2021 Attraction
San Diego, CA

Issue for Bid
PROJECT MANUAL
VOLUME 1 OF 2: DIV. 00-14
PGAV Project Number: 64096-00
Issue Date: March 5, 2020

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d/b/a SeaWorld San Diego

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SEAWORLD SAN DIEGO
SWSD 2021 ATTRACTION

ISSUE FOR BID

MARCH 5, 2020

THE COMPLETE LISTING OF CONTRACT DOCUMENTS IS TO BE PROVIDED BY THE OWNER

PROJECT MANUAL:

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS DOCUMENTS ARE PROVIDED BY THE OWNER

VOLUME 1

DIVISION 11 – EQUIPMENT

NOT USED

DIVISION 12 – FURNISHINGS

NOT USED

DIVISION 13 – SPECIAL CONSTRUCTION

131420 THEME PROPS
131433 RIDE ACTUATING GATES

DIVISION 14 – CONVEYING EQUIPMENT

NOT USED

VOLUME 2

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CHRISTIAN WHEELER
ENGINEERING

PRELIMINARY GEOTECHNICAL INVESTIGATION

SEAWORLD 2021 PROJECT
SEAWORLD ENTERTAINMENT PARK
500 SEA WORLD DRIVE
SAN DIEGO, CALIFORNIA

PREPARED FOR

SEAWORLD ADVENTURE PARK
500 SEA WORLD DRIVE
SAN DIEGO, CALIFORNIA 92109

PREPARED BY

CHRISTIAN WHEELER ENGINEERING
3980 HOME AVENUE
SAN DIEGO, CALIFORNIA 92105

CHRISTIAN WHEELER
ENGINEERING

September 20, 2019

SeaWorld Adventure Park
500 Sea World Drive
San Diego, California 92109
Attention: James Potter

CWE 2190160.01

Subject: Report of Preliminary Geotechnical Investigation
2021 Project, East Parking Lot, SeaWorld Entertainment Park

Ladies and Gentlemen:

In accordance with your request and our proposal dated March 19, 2019, we have completed a geotechnical evaluation for the subject project. We are presenting herewith our findings and recommendations.

In general, it is our opinion that the subject site is suitable to support the proposed attraction provided the recommendations presented herein are incorporated into the design and construction. The main geotechnical and geologic conditions that will impact the proposed construction are the presence of potentially liquefiable soils and fill material within foundation zones of the proposed attractions that have a moderate settlement potential. As discussed in the attached report, these conditions can be mitigated through a combination of remedial grading and special foundation design.

If you have any questions after reviewing this report, please do not hesitate to contact our office. This opportunity to be of professional service is sincerely appreciated.

Respectfully submitted,
CHRISTIAN WHEELER ENGINEERING

Shawn C. Caya, R.G.E #2748

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SCC:scc;tsw

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CHRISTIAN WHEELER
ENGINEERING

PRELIMINARY GEOTECHNICAL INVESTIGATION

SEAWORLD 2021 PROJECT
SEAWORLD ENTERTAINMENT PARK
SAN DIEGO, CALIFORNIA

INTRODUCTION AND PROJECT DESCRIPTION

This report presents the results of our preliminary geotechnical investigation for the proposed 2021 project at the SeaWorld Entertainment Park, located on South Shores Drive, in San Diego, California. The following Figure No. 1 presents a vicinity map showing the location of the site.

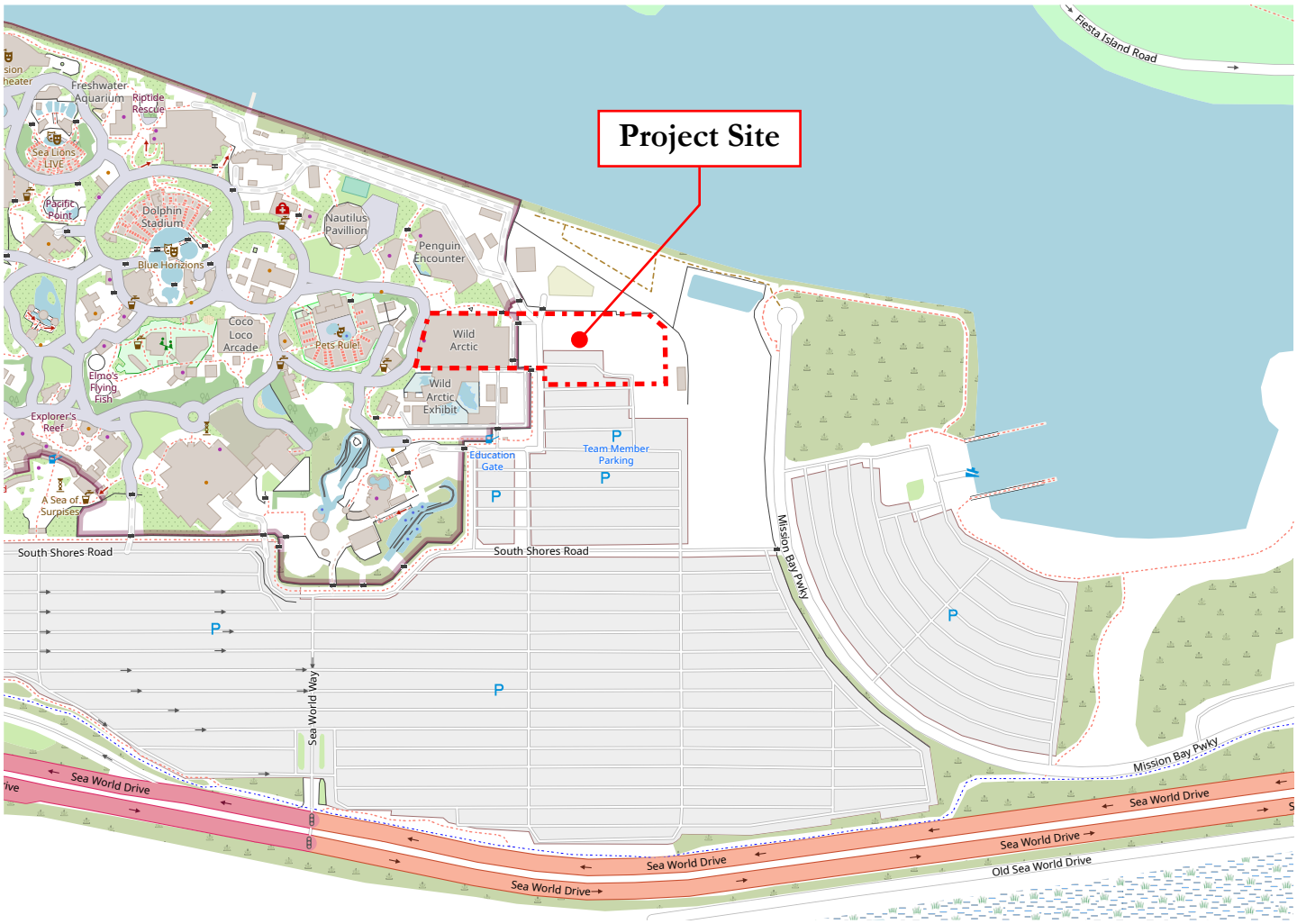
To aid in our understanding of the proposed project, we have been provided with Owner Review plans prepared by PGAV Destinations dated July 2, 2019. The Site Plan was used as the base map to show the approximate locations of previous and current subsurface explorations, and is included herewith as Plate No. 1. We have also discussed the project with representatives from Sea World, EDM Incorporated (structural engineer), and Intamin Amusement Rides.

Based on the plans provided, we understand that it is planned to construct a new ride in the eastern portion of the park. The ride will be located just to the east of the Wild Arctic attraction, in an area that is currently a paved parking lot and storage yard, and will incorporate a portion of the Wild Arctic MBT building for the queuing area. Additional structures will include a small building to house the ride electrical components. Grading for the project is expected to be minimal.

The coaster will be a steel-frame structure with several turns and elevation changes. We understand the maximum height will be roughly 30 feet above the existing grade. Vertical loads of up to 25 kips are anticipated. We understand that the ride manufacturer has specified a maximum permanent differential settlement of 0.7 millimeter per 1 meter of track span between columns, with a maximum of 15 millimeters (0.6 inch) for service conditions but will accept higher settlement totals for extreme design conditions such as earthquakes. We also understand that the coaster has a fundamental period of vibration less than 0.5 seconds and is considered a Risk Category II.

This report has been prepared for the exclusive use of SeaWorld Adventure Parks and its design consultants for specific application to the project described herein. Should the project be changed in any way, the modified

SITE VICINITY



SEAWORLD 2021 PROJECT 500 SEAWORLD DRIVE, SAN DIEGO, CA	
DATE: SEPTEMBER 2019	REPORT NO.: 2190160.01
BY: SCC	FIGURE NO.: 1

CHRISTIAN WHEELER ENGINEERING

plans should be submitted to Christian Wheeler Engineering for review to determine their conformance with our recommendations and to determine whether any additional subsurface investigation, laboratory testing and/or recommendations are necessary. Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties, express or implied.

SCOPE OF SERVICES

Our geotechnical investigation generally consisted of surface reconnaissance, subsurface exploration, review of previous subsurface explorations, analysis of the previous field data, and review of relevant readily available geologic literature. More specifically, our services included the following items.

- Obtaining a boring permit from the County of San Diego Department of Environmental Health to conduct the proposed subsurface investigation.
- Performing five Cone Penetrometer Tests (CPT) with a truck-mounted rig to explore the existing soil conditions. Shear wave velocity measurements were taken in one of the CPTs.
- Backfilling the CPT holes using a grout or a grout/bentonite mix as required by the County of San Diego Department of Environmental Health.
- Evaluating, by CPT data and our past experience with the park, the engineering properties of the various soil strata that may influence the proposed construction, including bearing capacities and settlement potential.
- Describing the general geology at the site, including possible geologic hazards that could have an effect on the proposed construction, and provide the seismic design parameters as required by the 2019 edition of the California Building Code.
- Addressing potential construction difficulties that may be encountered due to soil conditions, groundwater or geologic hazards, and provide geotechnical recommendations to deal with these difficulties.
- Quantitatively addressing the potential for soil liquefaction and dynamic settlement at the site in the event of a major, proximal seismic event.
- Providing site preparation and remedial grading recommendations for the anticipated work.
- Providing foundation recommendations for the type of construction anticipated and developing soil engineering design criteria for the recommended foundation designs.
- Providing this geotechnical report presenting the results of our evaluation, including a plot plan showing the locations of current and previous subsurface explorations, excavation logs, and our

conclusions and recommendations for the proposed project. The report will be provided as an electronic document in Portable Document Format (PDF).

It was not within the scope of our services to perform laboratory tests to evaluate the chemical characteristics of the on-site soils in regard to their potentially corrosive impact to on-grade concrete and below grade improvements. If requested, we can obtain and submit representative soil samples to a chemical laboratory for analysis; however, it should be understood that Christian Wheeler Engineering does not practice corrosion engineering. If such an analysis is necessary, we recommend that the client retain an engineering firm that specializes in this field to consult with them on this matter.

FINDINGS

SITE DESCRIPTION

The project site is located along the southern side of the Pacific Passage area of the Mission Bay Park, within the eastern portion of the SeaWorld lease-held property, in San Diego, California. The project site is generally located to the east of the existing Wild Arctic attraction and is currently a paved parking and storage area. The SeaWorld property and surrounding areas originally consisted of tidal flats that were reclaimed in the late 1950's by placing material dredged generated during the construction of Mission Bay as fill to raise the elevation. The specific project area has not previously supported structures. Topographically, the project area is relatively level with elevations generally ranging from about 17½ to 21½ feet based on the topographic map prepared by Rick Engineering (SeaWorld datum).

GENERAL GEOLOGY AND SUBSURFACE CONDITIONS

GEOLOGIC SETTING AND SOIL DESCRIPTION: The subject site is located in the Coastal Plains Physiographic Province of San Diego County. In order to evaluate the subsurface conditions at the project area, we have performed five Cone Penetration Tests at the subject site as well as reviewed previous subsurface explorations performed for the adjacent proposed 2020 project, and existing Journey to Atlantis and Wild Arctic attractions. Based on this information, our experience with the park, and our analysis of other readily available, pertinent geologic and geotechnical literature, we have determined that the site is underlain by artificial fill soils and estuarine deposits, which are underlain at depth by Quaternary-age paralic deposits. These materials are described below:

ARTIFICIAL FILL (Qaf): Mechanically- and hydraulically-placed fill materials are expected to extend to depths on the order of about 20 feet below the existing grades. Based on the similarities in composition and consistencies of these fill materials, no differentiation between mechanically- and hydraulically-placed fills is made in this report. In general, the upper three to five feet of fill materials consist of medium dense, moist, silty sand (SM) and poorly graded sand with silt (SP-SM). Below that depth, the fill materials typically consist of loose/soft, moist to saturated, sandy silt (ML) and silty sand (SM).

PARALIC ESTUARINE DEPOSITS (Qpe): Below the existing fill are Holocene-age estuarine deposits. The estuarine deposits consist of generally soft to medium stiff sandy silts (ML) and silty clays (CL) with interbeds of loose to medium dense silty sands (SM). These materials are below the water table and are saturated. Based on the results of our CPT soundings, the estuarine deposits are expected to extend to an approximate depth of 115 to 120 feet below the existing site grades.

OLD PARALIC DEPOSITS (Qop): The project area is underlain at depth by competent, Quaternary-age old paralic deposits. Though not observed, the old paralic deposits in the general site area typically consist of dense to very dense, clayey and silty sandstone and very stiff to hard, sandy claystone. Based on the results of previous CPT soundings, the old paralic deposits were encountered at a depth of 115 to 120 feet below the existing grades.

GROUNDWATER: Groundwater was measured in our Cone Penetration Tests at depths ranging from 15 to 18 feet below the existing grade. Using the topographic map by Rick Engineering, such depths correspond to elevations ranging from 2 to 5 feet. These elevations are consistent with our experience at the park, in which the local groundwater table is typically located at elevations ranging from about 2 feet to 6 feet (SeaWorld datum). However, it should be noted that the borings drilled for the adjacent Wild Artic attraction encountered groundwater at depths ranging from 9 to 15 feet below previously existing grades, which correlates to elevations of 5½ feet to 13½ feet (MSL datum per previous report). It should be noted that shallower zones of perched groundwater or wet to nearly saturated fine clays and silts are also common above the water table in the hydraulically-placed fills. Variations in subsurface water (including perched water zones and seepage) may result from fluctuations in the ground surface topography, subsurface stratification, precipitation, irrigation, and other factors that may not have been evident at the time of the investigation. It should also be recognized that minor groundwater seepage problems might occur after development of a site even where none were present before development. These are usually minor phenomena and are often the result of an alteration in drainage patterns and/or an increase in irrigation water. It is further our opinion that these problems can be most effectively corrected on an individual basis if and when they occur.

TECTONIC SETTING: It should be noted that much of Southern California, including the San Diego County area, is characterized by a series of Quaternary-age fault zones that consist of several individual, en echelon faults that generally strike in a northerly to northwesterly direction. Some of these fault zones (and the individual faults within the zones) are classified as "active" according to the criteria of the California Division of Mines and Geology. Active fault zones are those that have shown conclusive evidence of faulting during the Holocene Epoch (the most recent 11,000 years).

The Division of Mines and Geology used the term "potentially active" on Earthquake Fault Zone maps until 1988 to refer to all Quaternary-age faults for the purpose of evaluation for possible zonation in accordance with the Alquist-Priolo Earthquake Fault Zoning Act. The Alquist-Priolo Act requires the State Geologist to zone faults that are "sufficiently active" and "well-defined" to have a relatively high potential for ground rupture. The Division of Mines and Geology no longer uses the term "potentially active." However, the City of San Diego has elected to continue to use the term "potentially active" to refer to certain faults that demonstrated movement during the Pleistocene epoch (11,000 to 1.6 million years before the present) but that do not have substantiated Holocene movement. It should be recognized that the Alquist-Priolo Act (Division 2, Chapter 7.5, Section 2624) authorizes individual cities and counties to establish policies and criteria that are stricter than those established by the Alquist-Priolo Act.

A review of available geologic maps indicates that the active Rose Canyon Fault Zone is located approximately 1.5 miles to the east of the subject site. Other active fault zones in the region that could possibly affect the site include the Coronado Bank and San Clemente Fault Zones to the west, the offshore segment of the Newport-Inglewood and Palos Verdes Fault Zones to the northwest, and the Elsinore, Earthquake Valley, San Jacinto, and San Andreas Fault Zones to the northeast. The following Table I presents those proximal, active faults that are anticipated to most significantly contribute to the ground-motion hazard at the site.

TABLE I: PROXIMAL FAULT ZONES

Fault Zone	Distance
Rose Canyon	2.5 miles
Coronado Bank	10 miles
Newport-Inglewood	19 miles
Palos Verdes	38 miles
Elsinore	42 miles
San Clemente	46 miles
Earthquake Valley	47 miles
San Jacinto	62 miles
San Andreas	90 miles

GEOLOGIC HAZARDS

GEOLOGIC HAZARDS CATEGORY: The site is located in Geologic Hazard Category 31 according to the City of San Diego Seismic Safety Study (Sheet 20). Hazard Category 31 is assigned to areas characterized as having a high potential for soil liquefaction in the event of a major seismic event. Such characterization is based on the relatively shallow groundwater table and presence of hydraulic fills and other soft, cohesionless sediments within the area of the subject site. Discussion of the geologic hazards associated with seismically induced soil liquefaction at the subject site is presented in the Liquefaction and Lateral Ground Spreading sections of this report.

LANDSLIDE POTENTIAL AND SLOPE STABILITY: As part of this investigation we reviewed the publication, "Landslide Hazards in the Southern Part of the San Diego Metropolitan Area" by Tan, 1995. This reference is a comprehensive study that classifies San Diego County into areas of relative landslide susceptibility. The subject site is located in Area 1. Land within Area 1 is considered to be the least susceptible to slope failures. Based on the absence of significant slopes within the vicinity of the subject site, the potential for slope failures can be considered negligible.

SEISMIC HAZARD: A likely geologic hazard to affect the site is ground shaking as a result of movement along one of the major active fault zones mentioned in the "Tectonic Setting" section of this report. Seismic design parameters were determined in accordance with Chapter 16 of the *2019 California Building Code (CBC)* and the applicable sections of *ASCE/SEI 7-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. For the subject site, shear wave velocities measured in our CPT-1 indicate that the upper 100 feet of geologic subgrade has a V_{S30} value of 720 feet per second and can be characterized as Soil Site Class D.

It can be noted that sites underlain by liquefaction-susceptible soils should be designated as Soil Site Class F, requiring a site response analysis. However, as discussed in Section 20.3.1 of ASCE/SEI 7-16, for structures having fundamental periods of vibration equal to or less than 0.5 second, it is not required to perform a site response analysis. We understand that the proposed structures will have fundamental periods less than 0.5 second and can therefore be designed using Soil Site Class D as described above.

In accordance with Section 11.4.8 of ASCE/SEI 7-16, structures on Soil Site Class D or E sites that have a mapped MCE_R spectral response acceleration parameter (S_1) value greater than or equal to 0.2 require a site-specific ground motion hazard analysis or the seismic response coefficient (C_S) must be adjusted to adequately characterize the site response (Exception 2). The following Table II presents the seismic design parameters based on Exception 2 in Section 11.4.8.

TABLE II: CBC 2019/ASCE 7-16 – SEISMIC DESIGN PARAMETERS

CBC – Chapter 16 Section	Seismic Design Parameter	Recommended Value
Section 1613.2.2	Soil Site Class	D
Figure 1613.2.1 (1)	MCE_R Acceleration for Short Periods (0.2 sec), S_s	1.391 g
Figure 1613.2.1 (2)	MCE_R Acceleration for 1.0 Sec Periods (1.0 sec), S_1	0.480 g
Table 1613.2.3 (1)	Site Coefficient, F_a	1.000
Table 1613.3.3 (2)	Site Coefficient, F_v	1.820
Section 1613.2.3	S_{MS} = MCE_R Spectral Response at 0.2 sec. = $(S_s)(F_a)$	1.391 g
Section 1613.2.3	S_{M1} = MCE_R Spectral Response at 1.0 sec. = $(S_1)(F_v)$	0.874 g
Section 1613.2.4	S_{DS} = Design Spectral Response at 0.2 sec. = $2/3(S_{MS})$	0.927 g
Section 1613.2.4	S_{D1} = Design Spectral Response at 1.0 sec. = $2/3(S_{M1})$	0.582 g
Section 1613.2.5	Seismic Design Category	D
ASCE 7-16 Fig. 22-14	Mapped Long-Period Transition Period, T_L	8 sec
ASCE 7-16 Eq 12.8-3	Seismic Response Coefficient, C_S	Multiply by 1.5
Section 1803.2.12	PGA_M per Section 11.8.3 of ASCE 7	0.70 g

FLOODING: As delineated on the Flood Insurance Rate Map (Panel 1613F) prepared by the Federal Emergency Management Agency, the site is located within an area labeled as "Area of Minimal Flooding-Zone X."

TSUNAMIS: Tsunamis are great sea waves produced by a submarine earthquake or volcanic eruption. Historically, the San Diego area has been free of tsunami-related hazards and tsunamis reaching San Diego have generally been well within the normal tidal range. It is thought that the wide continental margin off the coast acts to diffuse and reflect the wave energy of remotely generated tsunamis. The largest historical tsunami to reach San Diego's coast was 4.6 feet high, generated by the 1960 earthquake in Chile. A lack of knowledge about the offshore fault systems makes it difficult to assess the risk due to locally generated tsunamis.

Portions of Mission Bay and surrounding areas are located within an area that may be affected by tsunamis. The Multi-Jurisdictional Hazard Mitigation Plan of the County of San Diego (URS, 2010) maps the project site outside of the area susceptible to the maximum projected runup from a tsunami. Additionally, as presented on the La Jolla Quadrangle of the State's Tsunami Inundation Map for Emergency Planning (June, 2009), the subject site is outside of the area of anticipated tsunami runup. Furthermore, although the Mission Bay area is within an area that may be affected by tsunamis, based on the bathymetry of the bay and offshore San Diego coastline, the fact that historical tsunamis reaching San Diego have generally been well within the normal tidal range, the distance from the site to the entrance to Mission Bay, and the elevation of the site of ±23-25 feet, it is our professional opinion and judgment that tsunami hazard at the site is relatively low and no greater at the subject site than it is along the adjacent areas of the entertainment park and other portions

of Mission Bay that are not in close proximity to the bay's entrance or the barrier beach area along the west side of Mission Beach.

SEICHES: Seiches are periodic oscillations in large bodies of water such as lakes, harbors, bays or reservoirs. Although the site is located adjacent to Mission Bay, due to the size and configuration of Mission Bay, it is our opinion that the risk potential for damage caused by seiches is relatively low.

LIQUEFACTION

GENERAL: The subject site is in an area considered susceptible to liquefaction. In order to be subject to liquefaction, three conditions must be present: loose sandy or cohesionless silty deposits, shallow groundwater, and earthquake shaking of sufficient magnitude and duration. Based on our site-specific study, it appears that shallow groundwater is present at the site and strong earthquake shaking may affect the site. Additionally, as described in the Geologic Setting and Soil Description section of this report above, the materials below the shallow water table in the project area consist of Holocene-age fill material and estuarine deposits that contain layers of sand, silty sand, and low to medium plasticity silts (ML) that are expected to have soil properties conducive to liquefaction.

It should be noted that the following discussion is in no way a guarantee that the analysis will accurately predict the liquefaction potential at the site. The analysis provides general information only on the site liquefaction potential. It should be noted that many of the parameters used in liquefaction evaluations are subjective and open to interpretation, and that much is yet unknown about both the seismicity of the San Diego area and the phenomenon of liquefaction.

DESCRIPTION OF ANALYSIS: Our analysis was performed using the Cliq (version 3.0) software developed by Geologismiki, in which the results of our CPT soundings were input and evaluated in accordance with the procedure recommended by the National Center For Earthquake Engineering Research (NCEER, 1998). Our analyses were limited to the upper 60 feet of the existing soils below the proposed improvements. Liquefaction of soils at greater depths is expected to be less likely based on the age of the deeper soils. Additionally, an algorithm was applied within the software to make corrections for thin stiff layers embedded within softer zones (Robertson, 2009).

EARTHQUAKE PARAMETERS: As permitted in Section 1803.5.12 of the California Building Code, our calculations were performed using a peak ground acceleration ($PGA_M = 0.70g$) as determined using the procedures set forth in Section 11.8.3 of ASCE 7-16. We have also performed a seismic hazard deaggregation

using the interactive program available on the U. S. Geological Survey website. Within the USGS program, the site coordinates were entered and a deaggregation was performed based on the peak ground acceleration with one percent probability of exceedance in 50 years (0.78g) for soil with Vs^{30} = 260 m/s (Soil Site Class D). For the subject site, this yielded a modal earthquake magnitude of 6.9. Based on this result and the proximity of the site to the Rose Canyon (7.2 Magnitude) and Coronado Bank (7.6 Magnitude) Fault Zones, this result was used in our analyses.

POTENTIAL FOR LIQUEFACTION: Using the parameters described above, the results of our liquefaction analyses indicate that much of the saturated sandy and silty portions of the estuarine deposits within the upper 60 feet of soil below the proposed improvements possess factors-of-safety against soil liquefaction of less than 1.0 and are therefore considered potentially liquefiable. A complete report of our analysis is presented in Appendix C of this report.

POST LIQUEFACTION RECONSOLIDATION SETTLEMENT: The potential amount of total vertical settlement due to reconsolidation of the liquefied soils was estimated within the Cliq software using the methods presented by Zhang et al, 2002 with a depth-weighted dynamic settlement profile (Cetin et al, 2009) as recommended by Dr. Peter Robertson (2014). The estimated settlement within our five CPTs ranged from about 1 to 3 inches, with an average of nearly 2 inches. It can be noted that, for sites with relatively small lateral displacement (i.e. less than one foot), predicted settlements are typically within a factor of two relative to those observed (Seed et al, 2003).

In terms of differential settlement, CGS Special Publication 117 notes that considerable difficulty exists in trying to "reliably estimate" the amount of differential settlement at a site caused by soil liquefaction. As such, a conservative estimate of differential settlement at any given site can be assumed to be two-thirds of the total liquefaction-induced settlement (CGS, 2008). Using this criterion, without any deep ground modification, the subject project area may be assumed to be subject to approximately 2 inches of liquefaction-induced, differential settlement. This estimated differential settlement can be assumed to occur over a horizontal distance of 40 feet, which equates to an angular distortion of 0.0041L.

LATERAL SPREADING: Lateral ground spreading can occur when viscous liquefied soils flow downslope, usually towards a river channel or shoreline. Within the referenced Cliq software, the results of our liquefaction analyses were used in conjunction with the methodology developed by Zhang, Robertson, and Brachman (2004) to estimate the value of lateral spreading for a gently sloping ground surface with no free face. Based on the results of our analyses, the estimated lateral spreading value for the design earthquake conditions is between approximately 3 to 9 inches.

CONCLUSIONS

In general, it is our opinion that the subject site is suitable to support the proposed coaster attraction provided the geotechnical design and construction criteria presented in the following section are followed. Based on our investigation, we offer the conclusions listed below.

- The main geotechnical and geologic conditions that will impact the proposed construction are the presence of fill material at the anticipated foundation level with marginal strength characteristics and the potential for liquefaction of the underlying soils during a major seismic event.
- The structural engineer has evaluated using either shallow or deep foundation systems to support the coaster based on our preliminary geotechnical criteria. We understand that, based on the relatively small loads imparted by the coaster, shallow foundations are feasible. However, we understand that deeper foundations, such as augercast piles, may be needed based on the presence of underground improvements that cannot be relocated.
- The Guidelines for Evaluating and Mitigating Seismic Hazards in California (CGS, Special Publication 117A) indicates that for liquefiable sites "the minimum level of mitigation for a project should be to reduce the risk of ground failure during an earthquake to a level that does not cause the collapse of buildings for human occupancy, but in most cases not to a level of no ground failure at all." Based on our discussions with the coaster engineer from Intamin Amusement Rides, given the estimated differential settlement of 2 inches over 40 feet (0.0041L), the coaster structure is able to meet this standard and provide a life-safety performance level. Additionally, this estimated value of differential settlement does not exceed the threshold for "Other single-story structures" in Risk Category II supported on shallow foundations as noted in Table 12.3-3 in ASCE/SEI 7-16. Such acceptance, however, does preclude the possibility of some structural damage and settlement occurring as a result of a major seismic event to the extent that the coaster and associated buildings may need extensive repair or replacement.
- Where the planned structures are to be supported by shallow foundations, it will be necessary to perform remedial grading in the form of overexcavation and recompaction of the foundation soil. Additionally, pad footings should be connected via tie beams per ASCE/SEI 7-16.

RECOMMENDATIONS

GRADING AND EARTHWORK

GENERAL: All grading should conform to the guidelines presented in Appendix J of the California Building Code, the minimum requirements of the City of San Diego, and the following recommendations. Prior to grading, a representative of Christian Wheeler Engineering should be present at the preconstruction meeting to provide additional grading guidelines, if necessary, and to review the earthwork schedule.

OBSERVATION OF GRADING: Continuous observation by the Geotechnical Consultant is essential during the site preparation and grading operations to confirm conditions anticipated by our investigation, to allow adjustments in design criteria to reflect actual field conditions exposed, and to determine that the grading proceeds in general accordance with the recommendations contained herein.

CLEARING AND GRUBBING: Site grading should begin with the removal of all existing structures, asphalt and concrete pavement, trees, light poles and underground utilities in the portions of site that will be graded and/or will receive new improvements. Crushed asphalt and/or concrete can be incorporated into fills from a geotechnical standpoint provided the material meets the requirements in the "Compaction and Method of Filling" section of this report. The other removed materials should be disposed of off-site. Any abandoned underground pipes found during the grading operation should be removed and the resulting depressions backfilled with uniformly compacted fill material.

EXCAVATION CHARACTERISTICS: We expect that planned excavations and excavations for the removal of unsuitable soils can be made using normal grading equipment. However, it should be recognized that that some very fat, highly plastic clays or saturated silts are sometimes encountered above the water table. These materials will not support larger grading and may require special equipment and/or temporary stabilization. Additionally, the clay is not suitable for use as structural fill material. Other saturated soils may be used as fill provided they are dried back to a suitable moisture content (see "Compaction and Method of Filling" section). Also, it is not uncommon to find some buried debris in excavations. Any such material found that is determined by the geotechnical engineer to be unsuitable for fill material will also need to be disposed of off-site.

SITE PREPARATION: Specific site preparation recommendations for different elements of the proposed attraction are presented below. No special site preparation is necessary at this time where augercast piles are used. All fill should be placed in accordance with the "Compaction and Method of Filling" section of this report.

changed to 2'

- **Structures:** For structures that are supported by shallow foundations, we recommend that a mat of properly compacted fill be constructed below the shallow foundations. This mat should extend at least six feet below the bottom of the footing for the coaster and four feet below the bottom of the footing for other structures. Where possible, the mat should extend at least five feet outside the perimeter foundation. The recommended fill mat can be constructed by removing the existing soil and placing it back as properly compacted fill; however, prior to placing fill the bottom of the excavation should be approved by a member of our engineering or geology staff. If soft, pumping, or otherwise unsuitable soils are exposed at the removal bottom that cannot be properly compacted, it will be necessary to stabilize the bottom soils prior to placing structural fill (see Processing of Fill Areas).

- **Exterior Flatwork Areas:** In areas that will receive on-grade concrete flatwork, the subgrade soils should be scarified to a depth of at least 12 inches, moisture conditioned, and compacted in place prior to placing concrete. If soils considered to be unsuitable to support the flatwork are exposed in the subgrade, removals may be necessary. The depth of removal will need to be determined by our firm when such conditions are exposed.

PROCESSING OF FILL AREAS: Prior to placing any new fill soils or constructing any new improvements in areas that have been cleaned out and approved to receive fill, the exposed soils should be scarified to a depth of 12 inches, moisture-conditioned, and compacted to at least 90 percent relative compaction. If soft, pumping, or otherwise unsuitable soils are exposed at the removal bottom that cannot be properly compacted, it will be necessary to stabilize the bottom soils prior to placing structural fill. One method is to construct a stabilization blanket consisting of at least one foot of ¾-inch crushed rock wrapped entirely in stabilization/filter fabric such as Mirafi 600X (or equivalent). Adjoining fabric panels should be overlapped at least 12 inches. Depending on the degree of pumping, an alternative method of stabilization may consist of placing 2 to 3 layers of stabilization fabric, such as Mirafi HP570 (or equivalent), or grid material, such as Mirafi BX1100 (or equivalent), within the lower fill. The initial layer would be placed at the excavation bottom and subsequent layers would be placed at 1 foot vertical intervals. Adjoining panels should be overlapped at least 6 inches.

DEWATERING: Based on the expected construction and the above recommendations, we expect that the excavations for the proposed structures will be above the local water table; however, the excavations may encounter perched groundwater and/or very wet to saturated, fine silts. In this case, it will likely be necessary to perform localized dewatering during construction to remove water from the excavation. If excavations for deep utilities extend below the water table, we recommend that a contractor specializing in construction dewatering be retained to design and perform the necessary dewatering. It is recommended that such dewatering be

performed as much as possible on a localized basis in order to minimize its impact on adjacent improvements.

COMPACTION AND METHOD OF FILLING: All structural fill placed at the site should be compacted to a relative compaction of at least 90 percent of its maximum dry density as determined by ASTM Laboratory Test D1557. Fills should be placed at or slightly above optimum moisture content, in lifts six to eight inches thick, with each lift compacted by mechanical means. Fills should consist of approved earth material, free of trash or debris, roots, vegetation, or other materials determined to be unsuitable by our soil technicians or project geologist. Fill material should be free of rocks or lumps of soil in excess of twelve inches in maximum dimension. However, in the upper five feet of pad grade, no rocks or lumps of soil in excess of six inches should be allowed. All utility trench backfill should be compacted to a minimum of 90 percent of its maximum dry density.

TEMPORARY SLOPES: The contractor is solely responsible for designing and constructing stable, temporary excavations and will need to shore, slope, or bench the sides of trench excavations as required to maintain the stability of the excavation sides. The contractor's "competent person", as defined in the OSHA Construction Standards for Excavations, 29 CFR, Part 1926, should evaluate the soil exposed in the excavations as part of the contractor's safety process. We anticipate that the existing on-site soils will consist of Type C material. Our firm should be contacted to observe all temporary cut slopes during grading to ascertain that no unforeseen adverse conditions exist. No surcharge loads such as foundation loads, or soil or equipment stockpiles, vehicles, etc. should be allowed within a distance from the top of temporary slopes equal to half the slope height.

SURFACE DRAINAGE: The ground around the proposed structures should be graded so that surface water flows rapidly away from the structure without ponding. In general, we recommend that the ground adjacent to structure slope away at a gradient of at least 5 percent for a minimum distance of 10 feet. If the minimum distance of 10 feet cannot be achieved, an alternative method of drainage runoff away from the building at the termination of the 5 percent slope will need to be used. Swales and impervious surfaces that are located within 10 feet of the building should have a minimum slope of 2 percent. Rain gutters with downspouts that discharge runoff away from the structure into controlled drainage devices are also recommended.

GRADING PLAN REVIEW: The final grading plans should be submitted to this office for review in order to ascertain that the geotechnical recommendations remain applicable to the final plan and that no additional recommendations are needed due to changes in the anticipated development. Our firm should be notified of

changes to the proposed project that could necessitate revisions of or additions to the information contained herein.

SHALLOW FOUNDATIONS

GENERAL: Provided the above site preparation is performed, it is our opinion that the proposed structures can be supported by shallow foundation systems. We recommend that individual pad footings or widely-spaced continuous footings be connected with intersecting tie beams as discussed below in order to help mitigate the possible effects of liquefaction-induced differential settlement. The following design recommendations are considered the minimum based on anticipated soil conditions and are not intended to be lieu of structural considerations.

DIMENSIONS: New continuous and individual pad footings should have a minimum embedment of 24 inches below finish grade. Individual footings or widely-spaced continuous footings should be connected using tie beams per ASCE/SEI 7-16. Footing widths and the associated allowable bearing pressure can be determined using Table III based on the allowable settlement. Intermediate values can be determined by interpolation. The allowable bearing pressures are applicable to all load combinations using an allowable stress design including those with wind and seismic.

TABLE III: SHALLOW FOUNDATION WIDTHS AND ALLOWABLE BEARING PRESSURES

Footing Width (ft)	¼-inch Settlement	½-inch Settlement	1-inch Settlement
5	1,300 psf	2,500 psf	3,000
8	1,000 psf	2,000 psf	2,400
12	900 psf	1,600 psf	1,800
15	750 psf	1,250 psf	1,500

SPRING STIFFNESS: The spring stiffness can be determined based on the Method 1 equations presented in ASCE 41-13 and/or FEMA 356. The soil criteria for such evaluations are presented in Table IV. The poisson ratio was assumed to be 0.25 and the effective shear modulus was determined based on an average initial shear modulus determined from cone penetration tests and the effective shear modulus ratio given in Table 8-2 from ASCE 41-13.

TABLE IV: SOIL PROPERTIES FOR SPRING STIFFNESS

Design Level	PGA (g)	Soil Site Class	Shear Ratio G/Go	Poisson Ratio, v	Initial Shear, Go (ksf)	Effective Shear, G (ksf)
PGA_M	0.70	D	0.2	0.25	1,800	360

FOOTING REINFORCING: Reinforcement requirements for foundations should be provided by the project structural engineer. However, we recommend that the minimum reinforcing for continuous footings consist of at least four No. 5 steel reinforcing bars, with two No. 5 bars positioned near the bottom of the footing and two No. 5 bars positioned near the top of the footing.

LATERAL LOAD RESISTANCE: Lateral loads against foundations may be resisted by friction between the bottom of the footing and the supporting soil, and by the passive pressure against the footing. The coefficient of friction between concrete and soil may be considered to be 0.35. The passive resistance may be considered to be equal to an equivalent fluid weight of 350 pounds per cubic foot. These values are based on the assumption that the footings are poured tight against undisturbed soil. If a combination of the passive pressure and friction is used, the friction value should be reduced by one-third.

SETTLEMENT CHARACTERISTICS: The anticipated foundation settlement for the static condition are provided in Table III. It should be recognized that minor cracks normally occur in concrete slabs and foundations due to shrinkage during curing or redistribution of stresses, therefore some cracks should be anticipated. Such cracks are not necessarily an indication of excessive vertical movements. The estimated total and differential settlement in the event of liquefaction due to a design level earthquake event is 3 inches and 2 inches over a horizontal distance of 40 feet, respectively.

EXPANSIVE CHARACTERISTICS: Due to the generally "low" expansive potential of the on-site soils, special foundation design recommendations for heaving soils are considered unnecessary.

FOUNDATION EXCAVATION OBSERVATION: All footing excavations should be observed by Christian Wheeler Engineering prior to placing formwork or reinforcing steel to determine if the foundation recommendations presented herein are followed and that the foundation soils are as anticipated in the preparation of this report. All footing excavations should be excavated neat, level, and square. All loose or unsuitable material should be removed prior to the placement of concrete.

AUGERCAST PILES

GENERAL: We understand that 18-inch diameter augercast piles may be used to support the coaster. The project structural engineer should design all pile locations, dimensions, and reinforcing using the recommendations and design parameters presented below. The following foundation design criteria are intended to meet the maximum total and differential settlements requirements under typical service load conditions. Based on our discussions with the coaster engineer from Intamin, the coaster structure is able to provide a life-safety performance level given the estimated differential settlement of 2 inches in the event of soil liquefaction. The following geotechnical design criteria are not intended to limit the displacement of the structure in the event of liquefaction.

AXIAL CAPACITY: Based on the relatively high displacements that are necessary to mobilize end bearing resistance and the given settlement criteria, we recommend that the piles be designed based solely on frictional resistance. For dead plus live load conditions, the ultimate frictional resistance along the side of the pile can be taken as 1,000 pounds per square foot (psf). Assuming a safety factor of 2, the allowable frictional resistance can be taken as 500 psf. The allowable resistance may be increased by one-third when considering temporary loads such as wind. For earthquake loads, we recommend an ultimate frictional resistance 750 psf be used.

LPILE SOIL PARAMETERS: We understand that the project structural engineer will evaluate the lateral capacity of the augercast piles using the computer program LPILE. Table V provides a summary of the recommended soil parameters to be used in the evaluation.

TABLE V: LPILE SOIL PARAMETERS

Elevation Interval (ft)	Depth (ft)	Soil Type	Unit Weight (pci)	Undrained Shear Strength (psi)	Friction Angle (degrees)
17 to 7	0 to 10	Sand	0.0069	--	34
7 to -1	10 to 18	Stiff Clay without Free Water	0.0069	7	--
-1 to -7	18 to 24	Stiff Clay with Free Water	0.0033	9	--
-7 to -20	24 to 37	Sand	0.0033	--	38
-20 to -25	37 to 42	Stiff Clay with Free Water	0.0033	4	--
-25 to -43	42 to 60	Sand	0.0033	--	32

Note: Program default values can be used for soil input parameters ε_{50} and k.

TABLE VI: LPILE P-MULTIPLIER FOR GROUP EFFECTS

Center-to-Center Spacing in Pile Diameters	p-multiplier		
	First (Leading) Row	Second Row	Third Row
6	0.90	0.90	0.80
5	0.85	0.80	0.70
4	0.80	0.70	0.60
3	0.75	0.55	0.40

Group effects can be neglected for piles with a center-to-center spacing equal to 7 pile diameters or greater. For pile groups with center-to-center spacing closer than 7 piles diameters, a p-multiplier should be applied in the direction of loading to the p-y curves as shown in Table VI above.

AUGERCAST PILE CONSTRUCTION CONSIDERATIONS: The performance of auger-cast piles is dependent to a great extent on proper installation technique. We recommend that a contractor familiar and experienced with the installation of augercast piles be retained on the project. The following items should be considered during the construction of auger-cast piles:

- The rate of drilling penetration and rotation should be maintained at a level such that the auger is advanced without excessive mining of the soil along the pile sides.
- Once the required tip elevation is reached, grouting should begin immediately. The initial lift to blow the plug should limited to six inches (150 mm) in order to minimize potential stress relief at the bearing surface.
- After the initial lift, the grout should be pumped with sufficient pressure and the auger withdrawn slowly enough to maintain the hole and allow lateral penetration of the grout into soft or porous zones of surrounding soil. For the lowest 3 to 6 feet (0.9 to 1.8 meters) of the hole, the delivered grout volume should be approximately 200 percent of the theoretical volume required to fill the pile for that length. For the remainder of the pile, the delivered grout volume should be at least 120 percent of the theoretical volume.
- The grout pressure and auger withdrawal rate should be maintained at steady levels in order to construct a pile of uniform diameter without "necking".
- The grout should include additives that control setting and shrinkage, and must be fluid enough to be pumped easily without excessive pressure losses.

- All reinforcement should be inserted before the grout sets up, normally within ten minutes after the augers are withdrawn. The reinforcement should be placed in the center of the pile, extend the full length of the pile, and be plumb to avoid having it protrude from the grout into the soil.

MONITORING: The project geotechnical engineer should provide full-time observation and testing of the pile installation. Observations will include review of drill rates and injection pressures as well as the grout volumes placed, all of which should be included in the contractor's logs in terms of units per depth (maximum of 3-foot intervals). Tests will include those to quantify the pertinent physical properties of the grout placed, such as flow and compressive strength.

Prior to construction of the test pile (see below), we recommend that the piling contractor prepare and submit a pile installation plan that provides the items listed below.

- The proposed equipment (including sizes) to be used.
- A step-by-step description of the installation procedure.
- Target drilling and grouting parameters for pile installation, including auger rotation speed, drilling penetration rates, torque, applied crowd pressures, grout pressures, and grout volume factors.
- Details of methods of reinforcement placement.
- Mix designs for all grout to be used.
- Equipment and procedures for monitoring and recording auger rotation speed, auger penetration rates, auger depths, crowd pressure, grout pressure, and grout volumes during installation.

TESTING PROGRAM: We recommend that at least one test pile for each pile type be installed with monitoring by the Geotechnical Consultant to evaluate the suitability of the contractor's installation procedures and equipment, as well as our design assumptions. We recommend the maximum test load be two times the design load. Based on the subsurface conditions encountered, we recommend using the "Quick Load Test Method" referenced in ASTM D1143. We recommend the 100 percent test load application be held and monitored for a period of four hours. If reaction piles are used for applying the test loads, a portion of the reaction piles installed should be similar to the test pile (i.e. augercast piles) to aid in the installation evaluation. The test pile can be used as a production pile as long as the net "set" experienced during the load tests is in acceptable ranges.

FOUNDATION PLAN REVIEW

The final foundation plan and accompanying details and notes should be submitted to this office for review. The intent of our review will be to verify that the plans used for construction reflect the minimum dimensioning criteria presented in this section and that no additional criteria are required due to changes in the foundation type or layout. It is not our intent to review structural plans, notes, details, or calculations to verify that the design engineer has correctly applied the geotechnical design values. It is the responsibility of the design engineer to properly design/specify the foundations and other structural elements based on the requirements of the structure and considering the information presented in this report.

ON-GRADE SLABS

INTERIOR SLABS: We recommend that the interior slab-on-grade floors for the buildings be at least five inches thick. Interior slabs should be reinforced with at least No. 3 bars spaced at least 18 inches on center each way. The owner and the project structural engineer should determine if the on-grade slabs need to be designed for special loading conditions. For such cases, a subgrade modulus of 150 pounds per cubic inch can be assumed for the subgrade provided it is prepared as recommended in this report.

UNDER-SLAB VAPOR RETARDERS: Where floor coverings are installed, steps should be taken to minimize the transmission of moisture vapor from the subsoil through the interior slabs where it can potentially damage the interior floor coverings. We recommend that the owner/contractor follow national standards for the installation of vapor retarders below interior slabs as presented in currently published standards including ACI 302, "Guide to Concrete Floor and Slab Construction" and ASTM E1643, "Standard Practice for Installation of Water Vapor Retarder Used in Contact with Earth or Granular Fill Under Concrete Slabs".

EXTERIOR CONCRETE FLATWORK: Exterior slabs not subject to vehicular traffic should have a minimum thickness of 4 inches. Slabs that will be support vehicular traffic should have a minimum thickness of 6 inches. Reinforcement can be placed in exterior concrete flatwork to reduce the potential for cracking and movement. Control joints should be placed in exterior concrete flatwork to help control the location of shrinkage cracks. Spacing of control joints should be in accordance with the American Concrete Institute specifications.

Special attention should be paid to the method of concrete curing to reduce the potential for excessive shrinkage and resultant random cracking. It should be recognized that minor cracks occur normally in concrete slabs due

to shrinkage. Some shrinkage cracks should be expected and are not necessarily an indication of excessive movement or structural distress.

EARTH RETAINING WALLS

PASSIVE PRESSURE: The passive pressure for the prevailing soil conditions may be considered to be 350 pounds per square foot per foot of depth for foundations in fill soil. This pressure may be increased one-third for seismic loading. The coefficient of friction for concrete to soil may be assumed to be 0.35 for the resistance to lateral movement. When combining frictional and passive resistance, the friction should be reduced by one-third. The upper 12 inches of exterior retaining wall footings should not be included in passive pressure calculations where abutted by landscaped areas.

ACTIVE PRESSURE: The active soil pressure for the design of unrestrained and restrained earth retaining structures with level backfill surface may be assumed to be equivalent to the pressure of a fluid weighing 35 and 55 pounds per cubic foot, respectively. Seismic pressure may be assumed to be equivalent to the pressure of a fluid weighing 15 pounds per cubic foot. In the case that the retaining wall is restrained at the top, the seismic pressure should be added only to the unrestrained value (35 pcf). Thirty percent of any area surcharge placed adjacent to the retaining wall may be assumed to act as a uniform horizontal pressure against the wall. If any other loads are anticipated, the Geotechnical Consultant should be contacted for the necessary increase in soil pressure. All values are based on a drained backfill condition.

WATERPROOFING AND SUBDRAINS: The project architect should provide (or coordinate) waterproofing details for the retaining walls. The design values presented above are based on a drained backfill condition and do not consider hydrostatic pressures. Unless hydrostatic pressures are incorporated into the design, the retaining wall designer should provide a subdrain detail. A typical retaining wall subdrain detail is presented as Plate No. 2 of this report. Additionally, outlets points for the retaining wall subdrains should be coordinated by the project civil engineer. For subterranean walls, it may be necessary to collect the subdrain water in sumps and then pump it to an appropriate outlet.

BACKFILL: All backfill soils should be compacted to at least 90 percent relative compaction. Expansive or clayey soils should not be used for backfill material. The wall should not be backfilled until the masonry has reached an adequate strength.

PRELIMINARY PAVEMENT SECTIONS

GENERAL: We expect that new asphalt concrete pavement will be installed for a new access road. The pavement sections provided in Table VII should be considered preliminary and should be used for planning purposes only. Final pavement designs should be determined after R-value tests have been performed in the actual subgrade material in place after grading. Presuming the grading recommendations presented previously are followed, we estimate that the subgrade soils will have an R-Value of at least 25. The Traffic Index and Traffic Categories shown below are assumed. The project client and/or civil engineer should determine whether these assumed values are appropriate for the traffic conditions.

ASPHALT CONCRETE: We expect that the access drive will primarily support passenger vehicles with only occasional heavily loaded vehicles such as delivery trucks and/or emergency vehicles with a maximum weight of 95,000 pounds. The asphalt concrete pavement section was calculated using the Caltrans design method using an assumed Traffic Index of 4.5.

TABLE VII: ASPHALT CONCRETE PAVEMENT SECTIONS

Pavement Type	Traffic Index	Pavement Thickness	Base Thickness	Base Material	Subgrade Compaction
Asphalt Concrete					
Access Road	4.5	3.0 in.	5.0 in.	CAB or Class II	95% in upper 12"
Access Road	4.5	3.0 in.	6.0 in.	CMB, PMB, Milled AC	95% in upper 12"

Remedial grading under the proposed pavement areas should be performed in accordance with the Site Preparation section of this report. Prior to placing the base material beneath asphalt concrete pavements, the subgrade soil should be scarified to a depth of 12 inches and compacted to at least 95 percent of its maximum dry density at a moisture content near optimum.

The base material could consist of Crushed Aggregate Base (CAB) or Class II Aggregate Base. The Crushed Aggregate Base should conform to the requirements set forth in Section 200-2.2 of the Standard Specifications for Public Works Construction. The Class II Aggregate Base should conform to requirements set forth in Section 26-1.02A of the Standard Specifications for California Department of Transportation. Use of other types of base material such as Crushed Miscellaneous Base, Processed Miscellaneous Base, or Milled asphalt concrete is acceptable provided 1 inch is added to the base thickness. Asphalt concrete should be placed in accordance with 'Standard Specifications for Public Works Construction (Greenbook), Section 302-5. Asphalt concrete pavement should be compacted to at least 95% of Hveem density.

LIMITATIONS

REVIEW, OBSERVATION AND TESTING

The recommendations presented in this report are contingent upon our review of final plans and specifications. Such plans and specifications should be made available to the Geotechnical Engineer and Engineering Geologist so that they may review and verify their compliance with this report and with Appendix J of the California Building Code.

It is recommended that Christian Wheeler Engineering be retained to provide continuous soil engineering services during the earthwork operations. This is to verify compliance with the design concepts, specifications or recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to start of construction.

UNIFORMITY OF CONDITIONS

The recommendations and opinions expressed in this report reflect our best estimate of the project requirements based on an evaluation of the subsurface soil conditions encountered at the subsurface exploration locations and on the assumption that the soil conditions do not deviate appreciably from those encountered. It should be recognized that the performance of the foundations and/or cut and fill slopes may be influenced by undisclosed or unforeseen variations in the soil conditions that may occur in the intermediate and unexplored areas. Any unusual conditions not covered in this report that may be encountered during site development should be brought to the attention of the Geotechnical Engineer so that he may make modifications if necessary.

CHANGE IN SCOPE

This office should be advised of any changes in the project scope or proposed site grading so that we may determine if the recommendations contained herein are appropriate. It should be verified in writing if the recommendations are found to be appropriate for the proposed changes or our recommendations should be modified by a written addendum.

TIME LIMITATIONS

The findings of this report are valid as of this date. Changes in the condition of a property can, however, occur with the passage of time, whether they are due to natural processes or the work of man on this or adjacent properties. In addition, changes in the Standards-of-Practice and/or Government Codes may occur. Due to such changes, the findings of this report may be invalidated wholly or in part by changes beyond our control. Therefore, this report should not be relied upon after a period of two years without a review by us verifying the suitability of the conclusions and recommendations.

PROFESSIONAL STANDARD

In the performance of our professional services, we comply with that level of care and skill ordinarily exercised by members of our profession currently practicing under similar conditions and in the same locality. The client recognizes that subsurface conditions may vary from those encountered at the locations where our borings, surveys, and explorations are made, and that our data, interpretations, and recommendations are based solely on the information obtained by us. We will be responsible for those data, interpretations, and recommendations, but shall not be responsible for the interpretations by others of the information developed. Our services consist of professional consultation and observation only, and no warranty of any kind whatsoever, express or implied, is made or intended in connection with the work performed or to be performed by us, or by our proposal for consulting or other services, or by our furnishing of oral or written reports or findings.

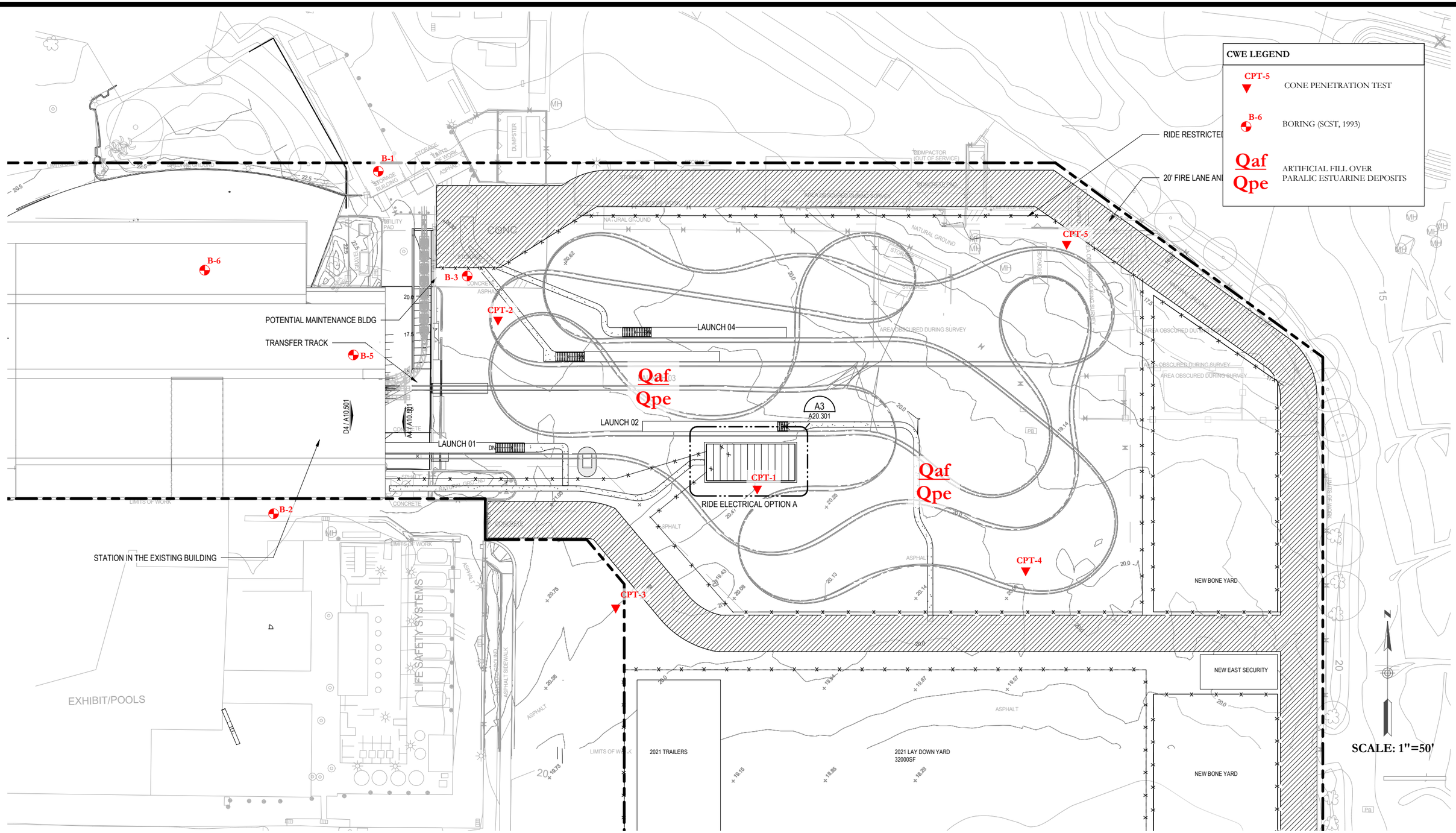
CLIENT'S RESPONSIBILITY

It is the responsibility of SeaWorld, or their representatives to ensure that the information and recommendations contained herein are brought to the attention of the structural engineer and architect for the project and incorporated into the project's plans and specifications. It is further their responsibility to take the necessary measures to insure that the contractor and his subcontractors carry out such recommendations during construction.

FIELD EXPLORATIONS

Five subsurface explorations were made during this investigation at the locations indicated on the Site Plan included herewith as Plate Number 1 on April 2, 2019. These explorations consisted of Cone Penetration Test soundings. The fieldwork was conducted under the observation and direction of our engineering geology personnel.

The CPT probes were performed by Kehoe Testing and Engineering, using an integrated electronic cone system. The results are presented in Appendix A. The CPT soundings were performed in accordance with ASTM Standard D5778. A 30-ton capacity cone was used for all of the soundings. This cone had a tip area equal to 15 square centimeters and friction sleeve area of 225 square centimeters. The cone was designed with an equal end area friction sleeve and a tip end area ratio of 0.85. The fieldwork was conducted under the observation and direction of our engineering geology personnel. On the logs of the CPT soundings, the soils are described in terms of the Soil Behavior Type (SBT). The stratigraphic expression of the soil types, SBT, is based on the relationships between the measured cone bearing, sleeve friction, and penetration pore pressures measured almost continuously within each sounding.

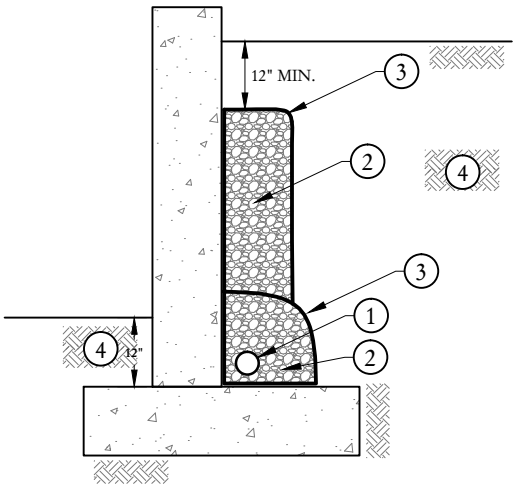


SITE PLAN AND GEOTECHNICAL MAP

SEAWORLD 2021 PROJECT
500 SEAWORLD DRIVE, SAN DIEGO, CA

DATE: SEPTEMBER 2019	REPORT NO.: 2190160.01
BY: SCC	PLATE NO.: 1

CHRISTIAN WHEELER ENGINEERING



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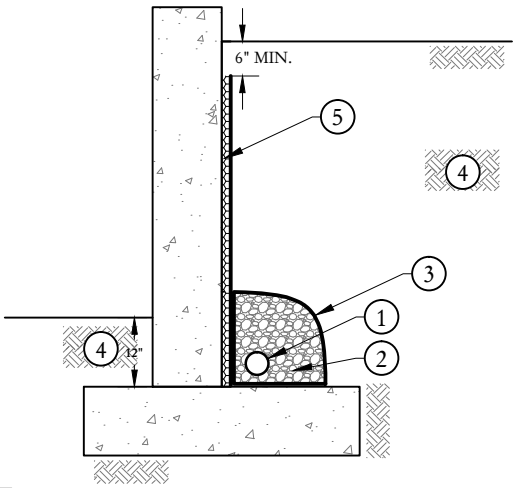

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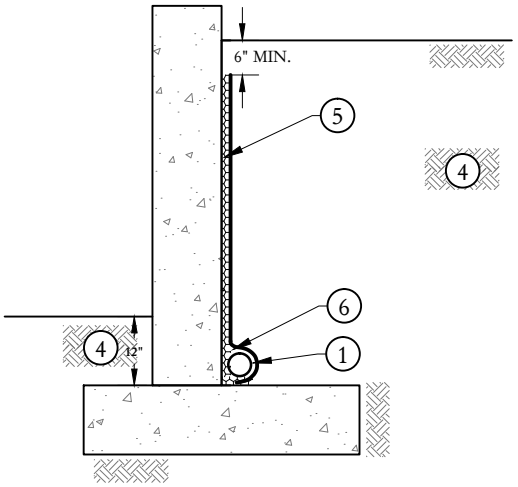

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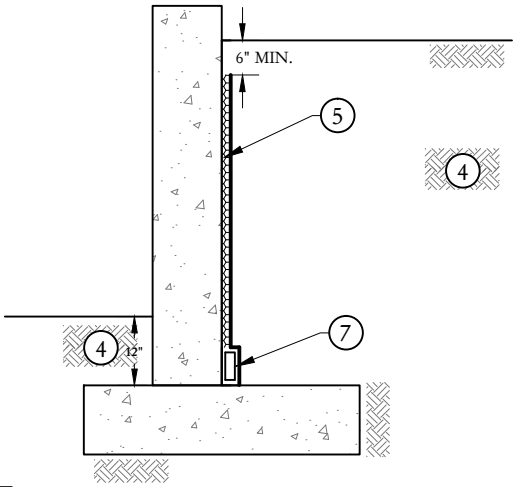


4 DETAIL

NOTES AND DETAILS

GENERAL NOTES:

1) THE NEED FOR WATERPROOFING SHOULD BE EVALUATED BY OTHERS.
2) WATERPROOFING TO BE DESIGNED BY OTHERS (CWE CAN PROVIDE A DESIGN IF REQUESTED).
3) EXTEND DRAIN TO SUITABLE DISCHARGE POINT PER CIVIL ENGINEER.
4) DO NOT CONNECT SURFACE DRAINS TO SUBDRAIN SYSTEM.

DETAILS:

1. 4-INCH PERFORATED PVC PIPE ON TOP OF FOOTING, HOLES POSITIONED DOWNWARD (SDR 35, SCHEDULE 40, OR EQUIVALENT).
2. ¾ INCH OPEN-GRADED CRUSHED AGGREGATE.
3. GEOFARBRIC WRAPPED COMPLETELY AROUND ROCK.
4. PROPERLY COMPACTED BACKFILL SOIL.
5. WALL DRAINAGE PANELS (MIRADRAIN OR EQUIVALENT) PLACED PER MANUFACTURER'S REC'S.
6. UNDERLAY SUBDRAIN WITH AND CUT FABRIC BACK FROM DRAINAGE PANELS AND WRAP FABRIC AROUND PIPE.
7. COLLECTION DRAIN (TOTAL DRAIN OR EQUIVALENT) LOCATED AT BASE OF WALL DRAINAGE PANEL PER MANUFACTURER'S RECOMMENDATIONS.

CANTILEVER RETAINING WALL DRAINAGE SYSTEMS

SEAWORLD 2021 PROJECT
500 SEAWORLD DRIVE, SAN DIEGO, CALIFORNIA

DATE:	SEPTEMBER 2019	JOB NO.:	2190160.01
BY:	SRD	PLATE NO.:	2

CHRISTIAN WHEELER
ENGINEERING

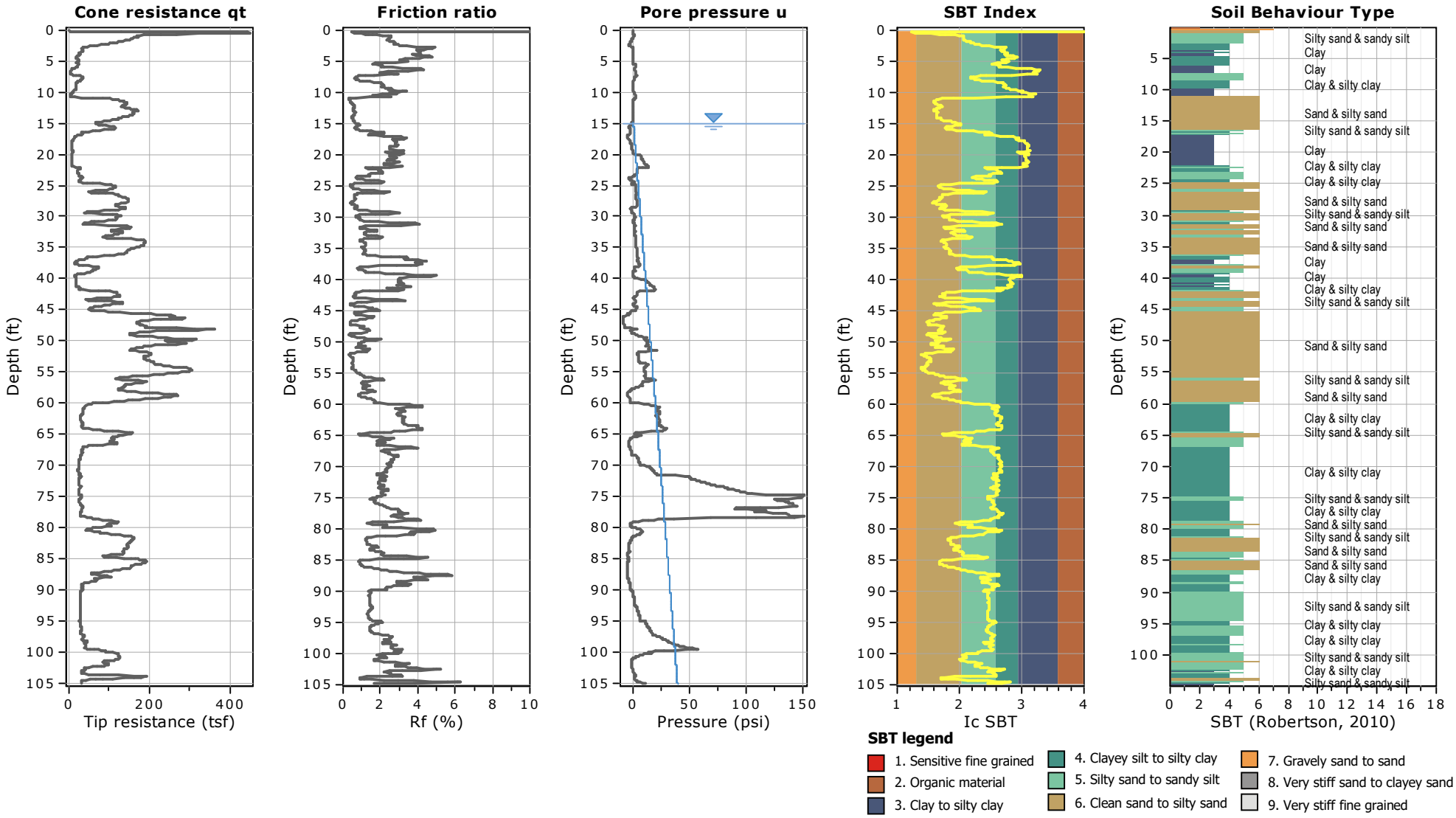
Appendix A

CPT Data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

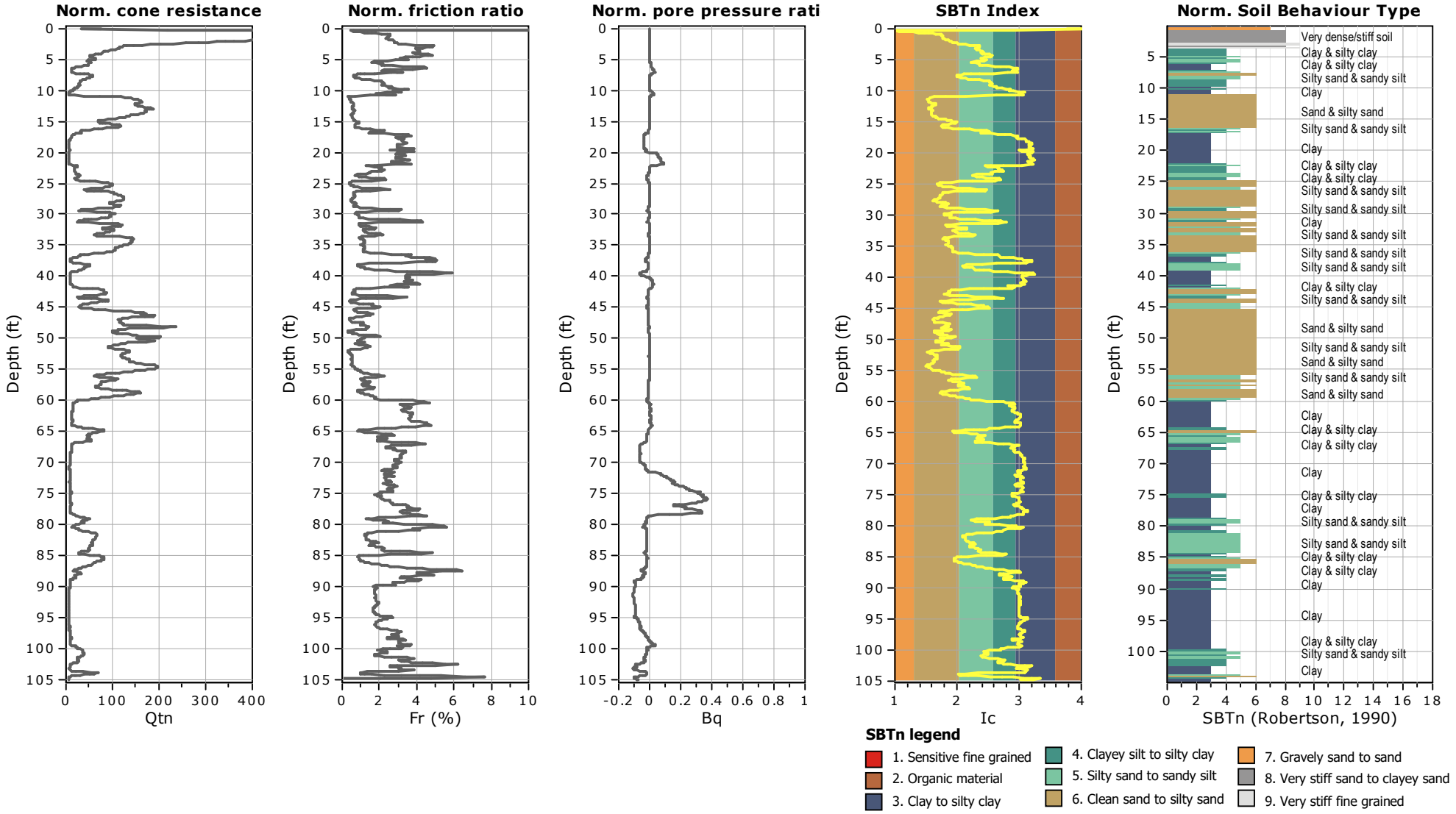
CPT: CPT-1
Total depth: 104.99 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

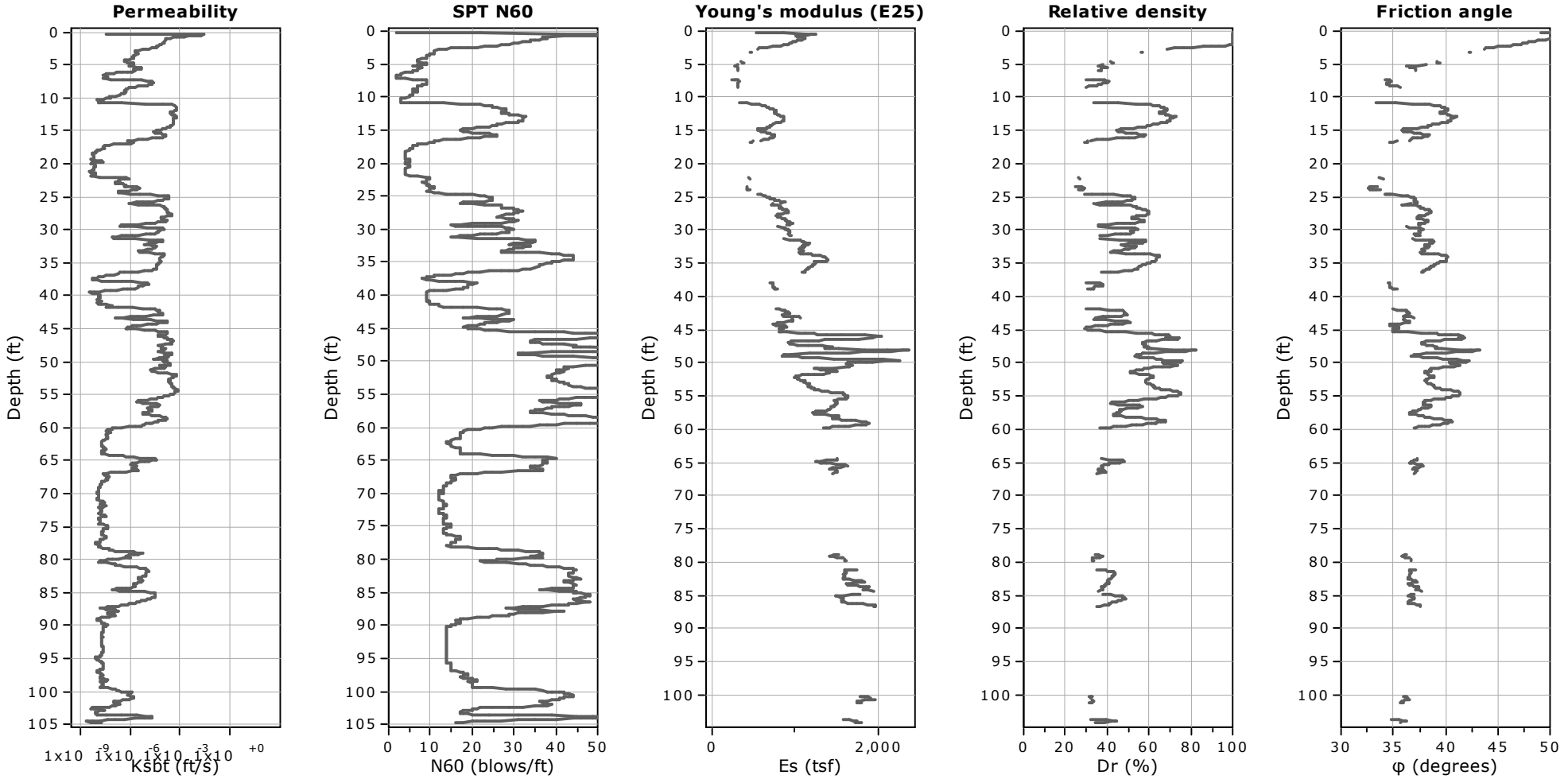
CPT: CPT-1
Total depth: 104.99 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

CPT: CPT-1
Total depth: 104.99 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**



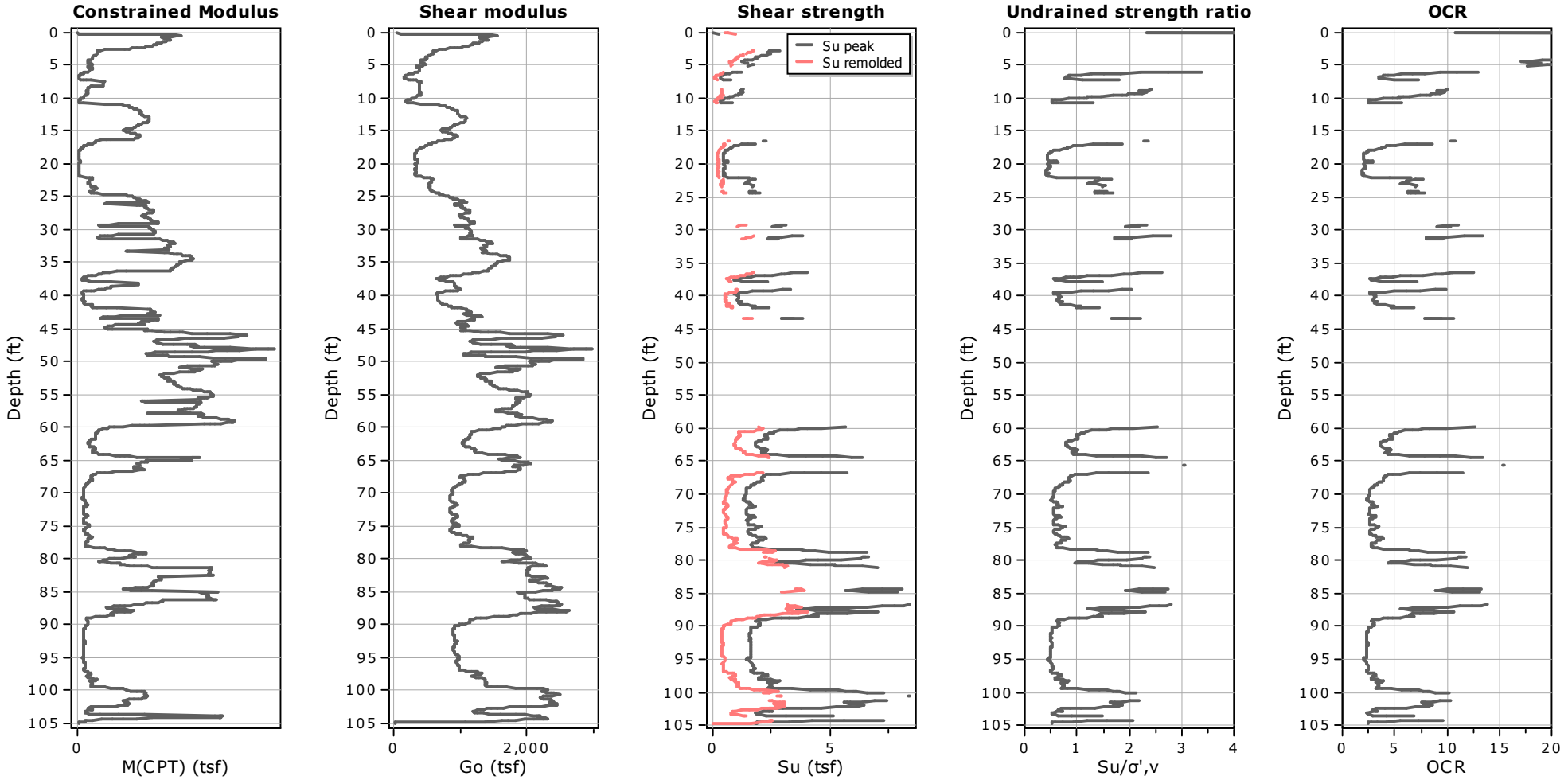
Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

CPT: CPT-1
Total depth: 104.99 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**



Calculation parameters

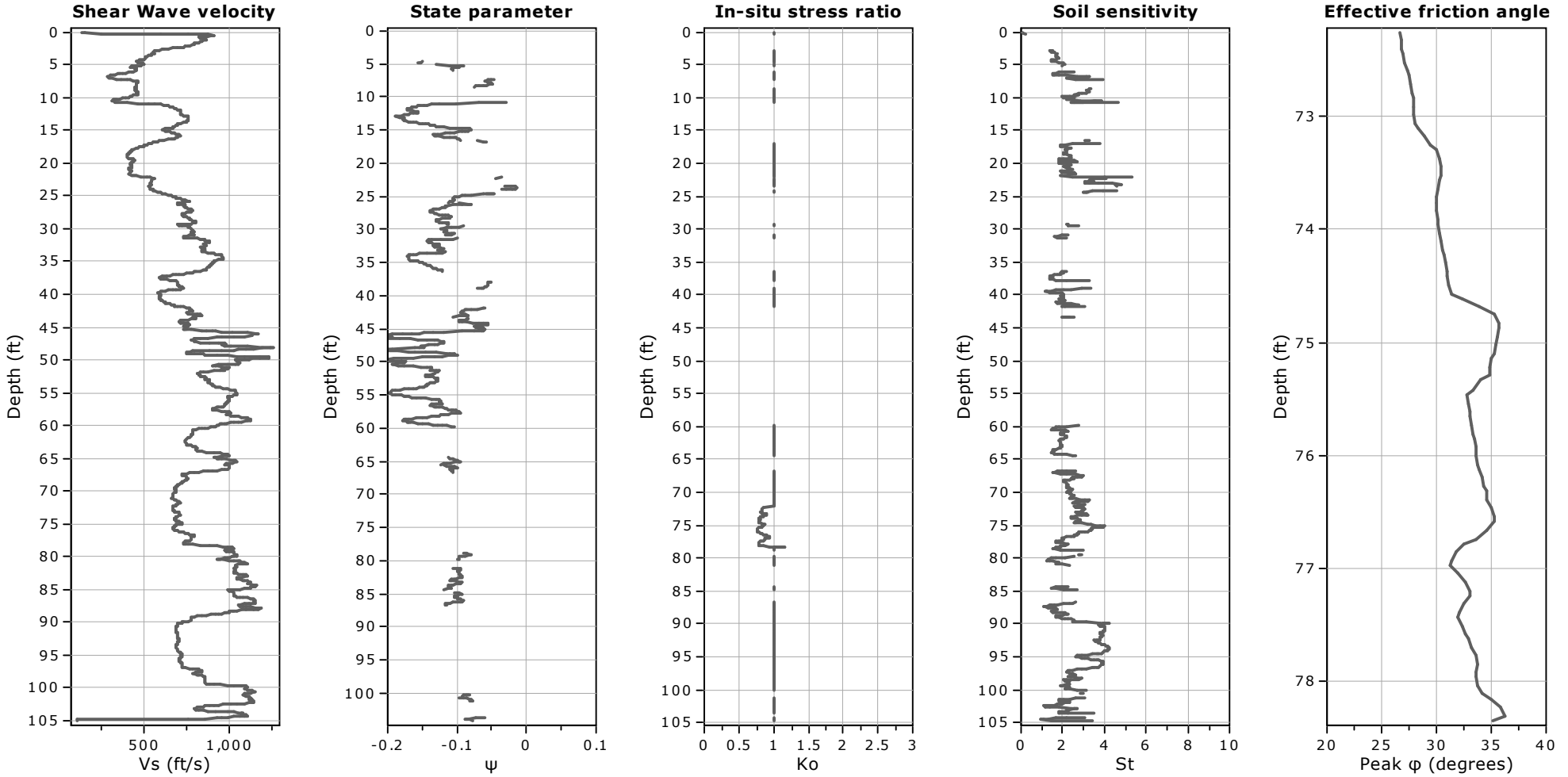
Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

CPT: CPT-1
Total depth: 104.99 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



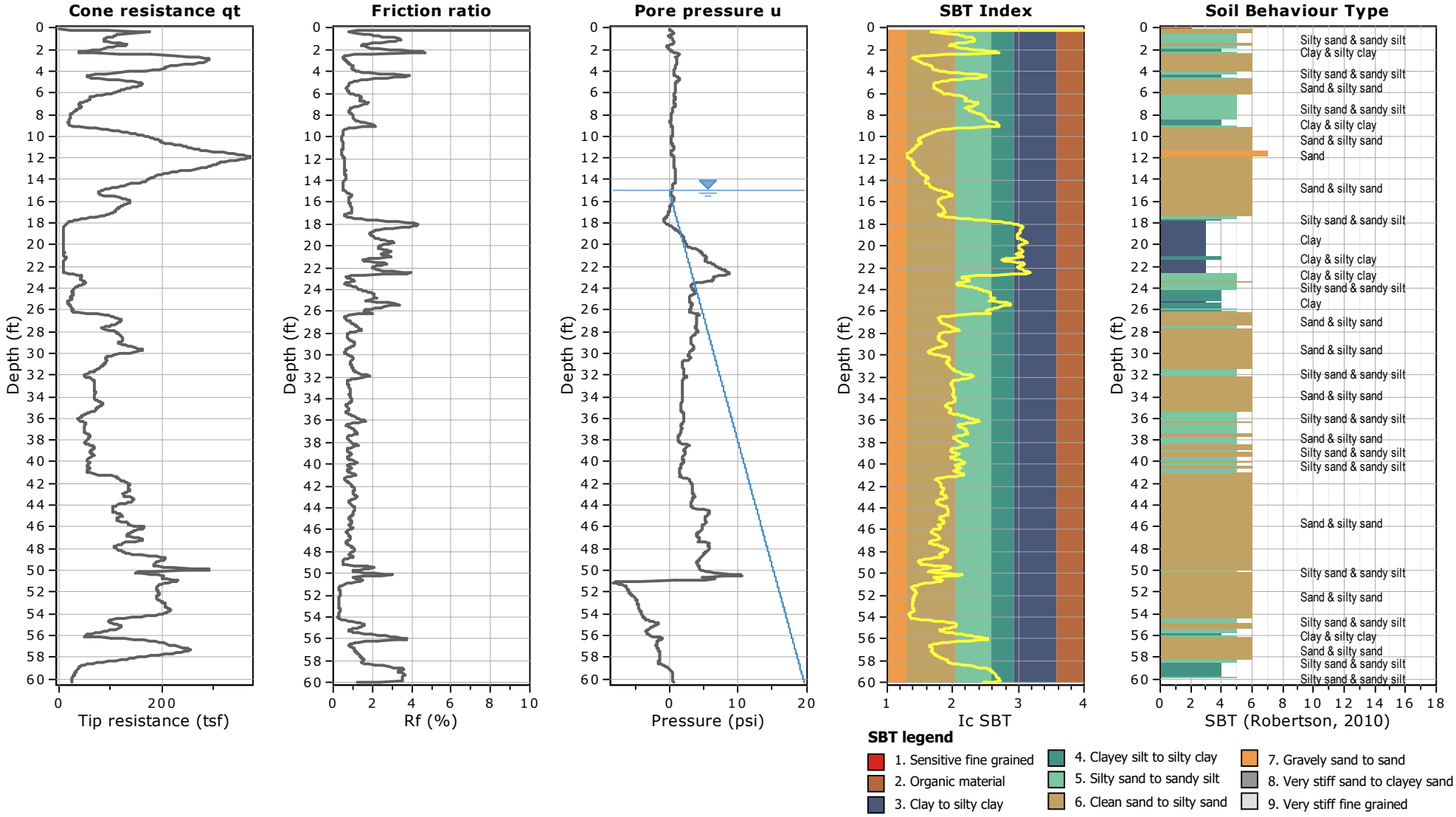
Calculation parameters

Soil Sensitivity factor, N_S: 7.00
User defined estimation data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

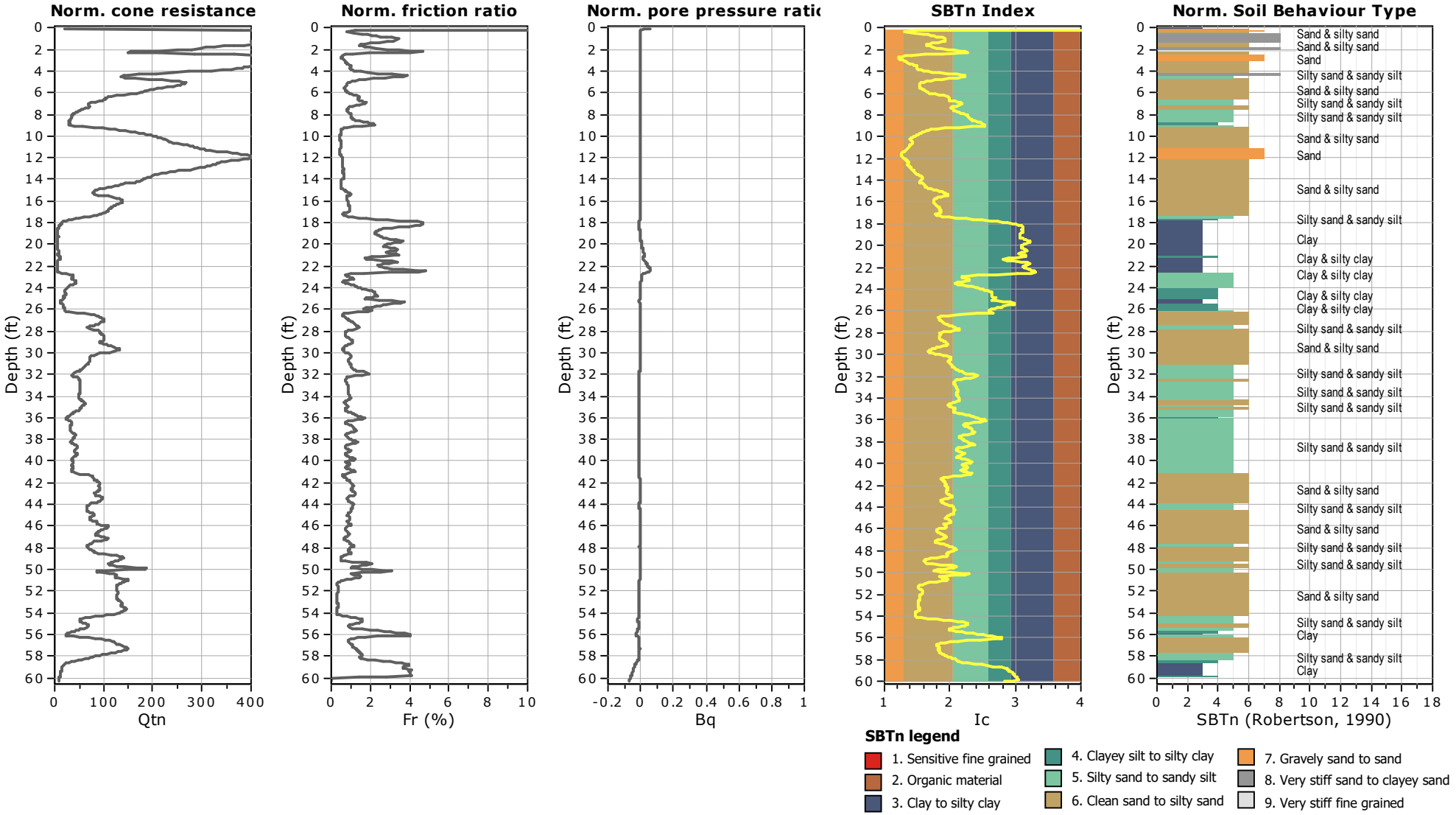
CPT: CPT-2
Total depth: 60.32 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

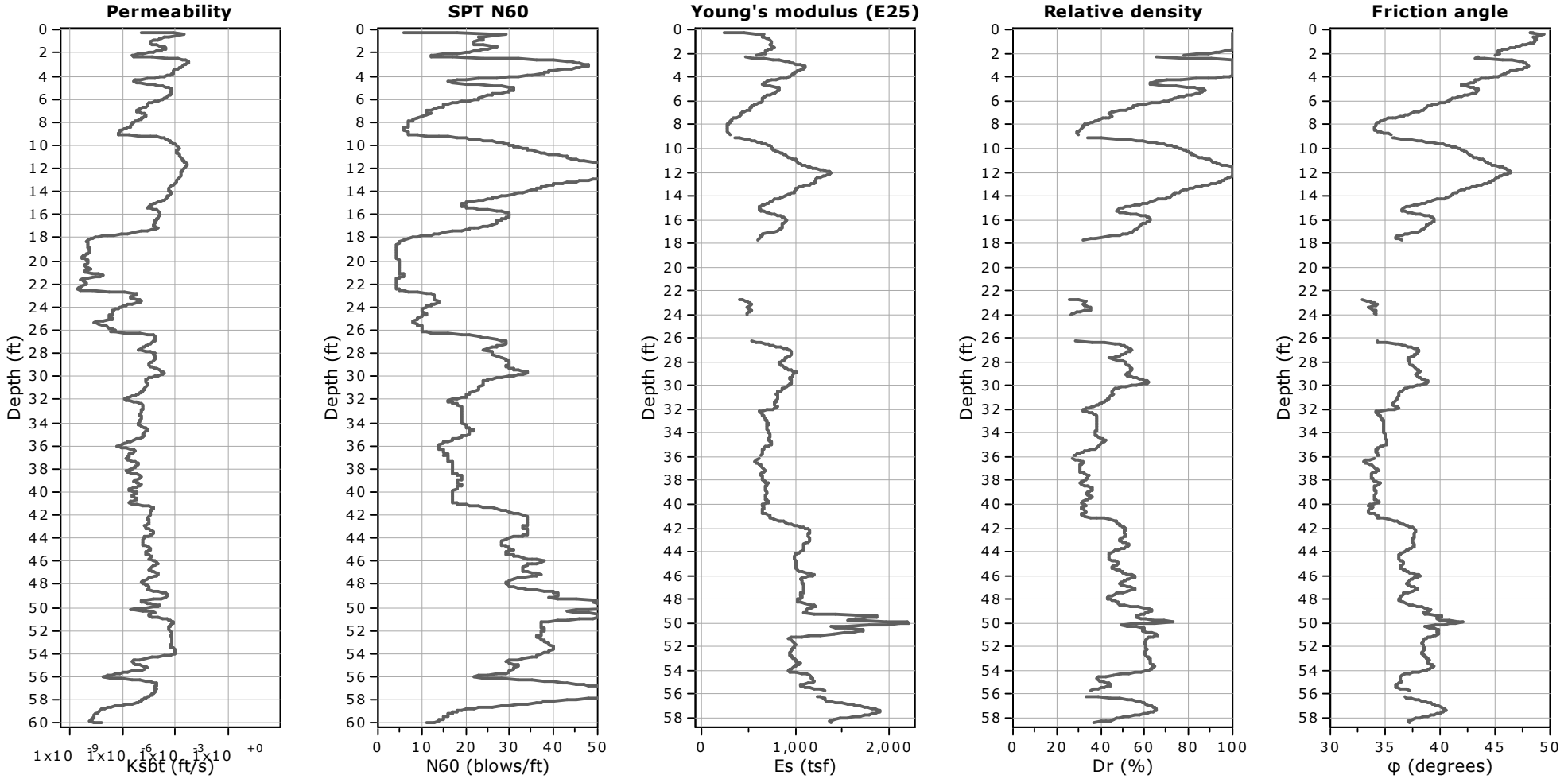
CPT: CPT-2
Total depth: 60.32 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

CPT: CPT-2
Total depth: 60.32 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**



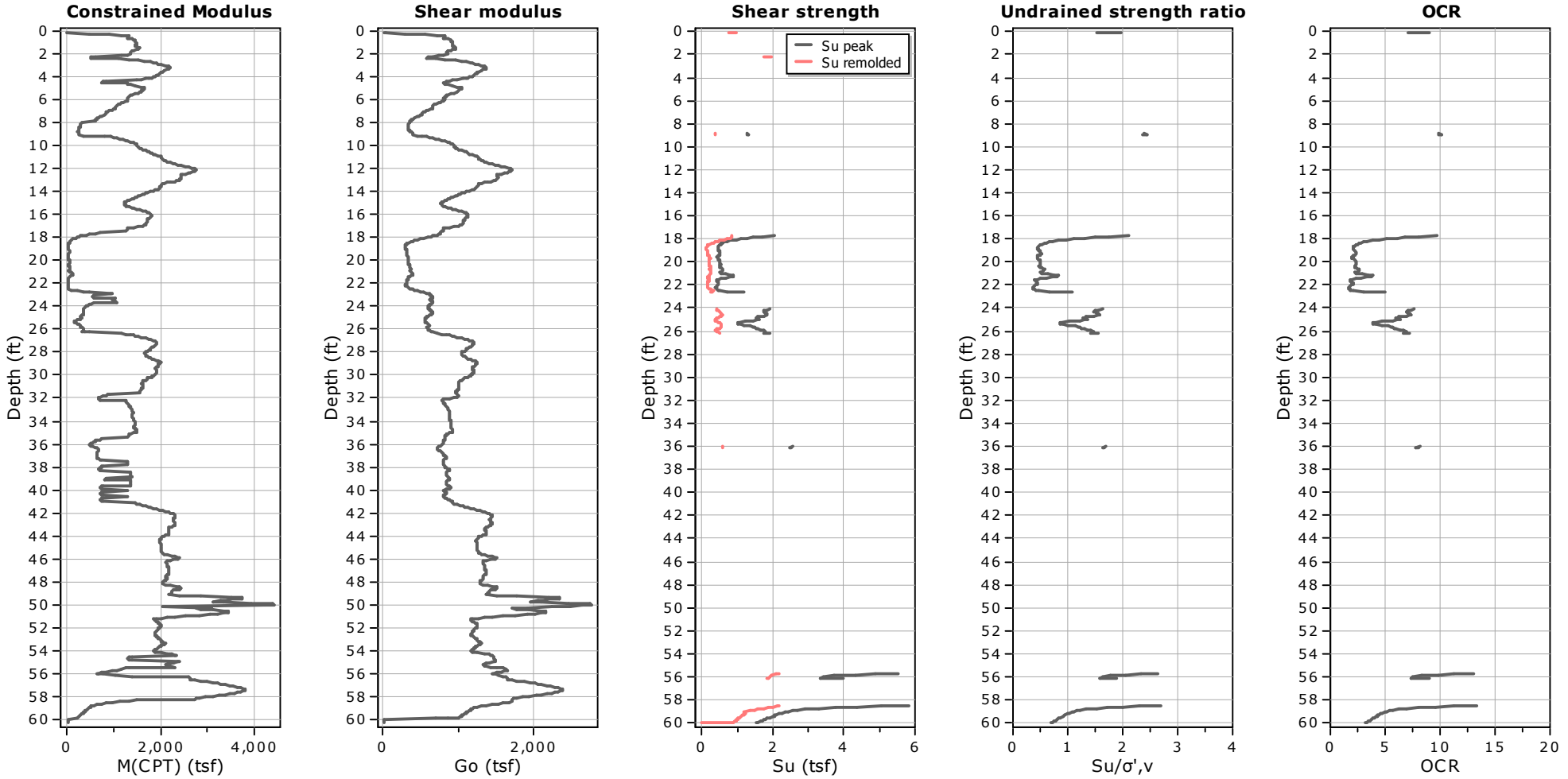
Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

CPT: CPT-2
Total depth: 60.32 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**



Calculation parameters

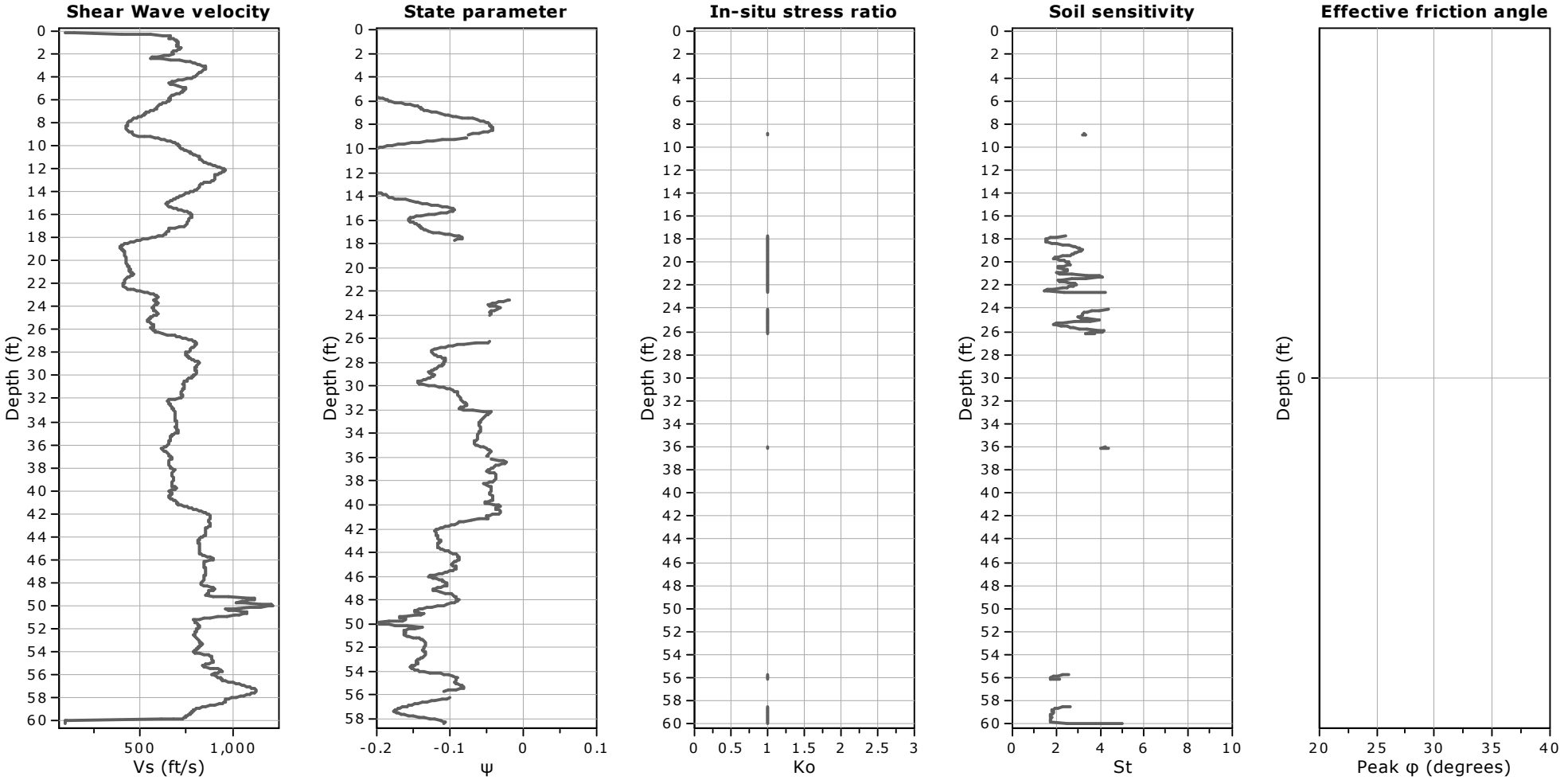
Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

CPT: CPT-2
Total depth: 60.32 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



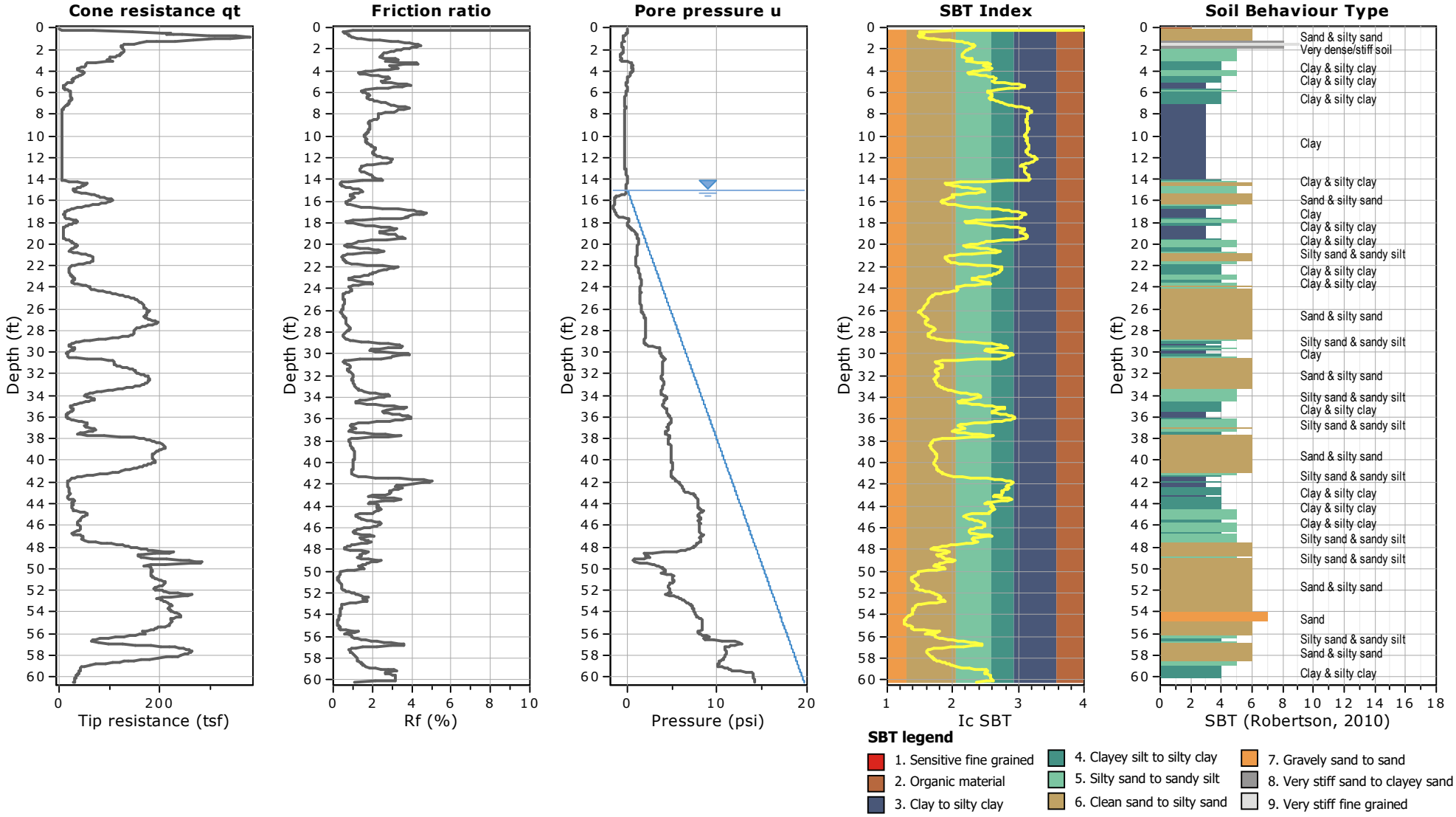
Calculation parameters

Soil Sensitivity factor, N_S: 7.00
User defined estimation data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

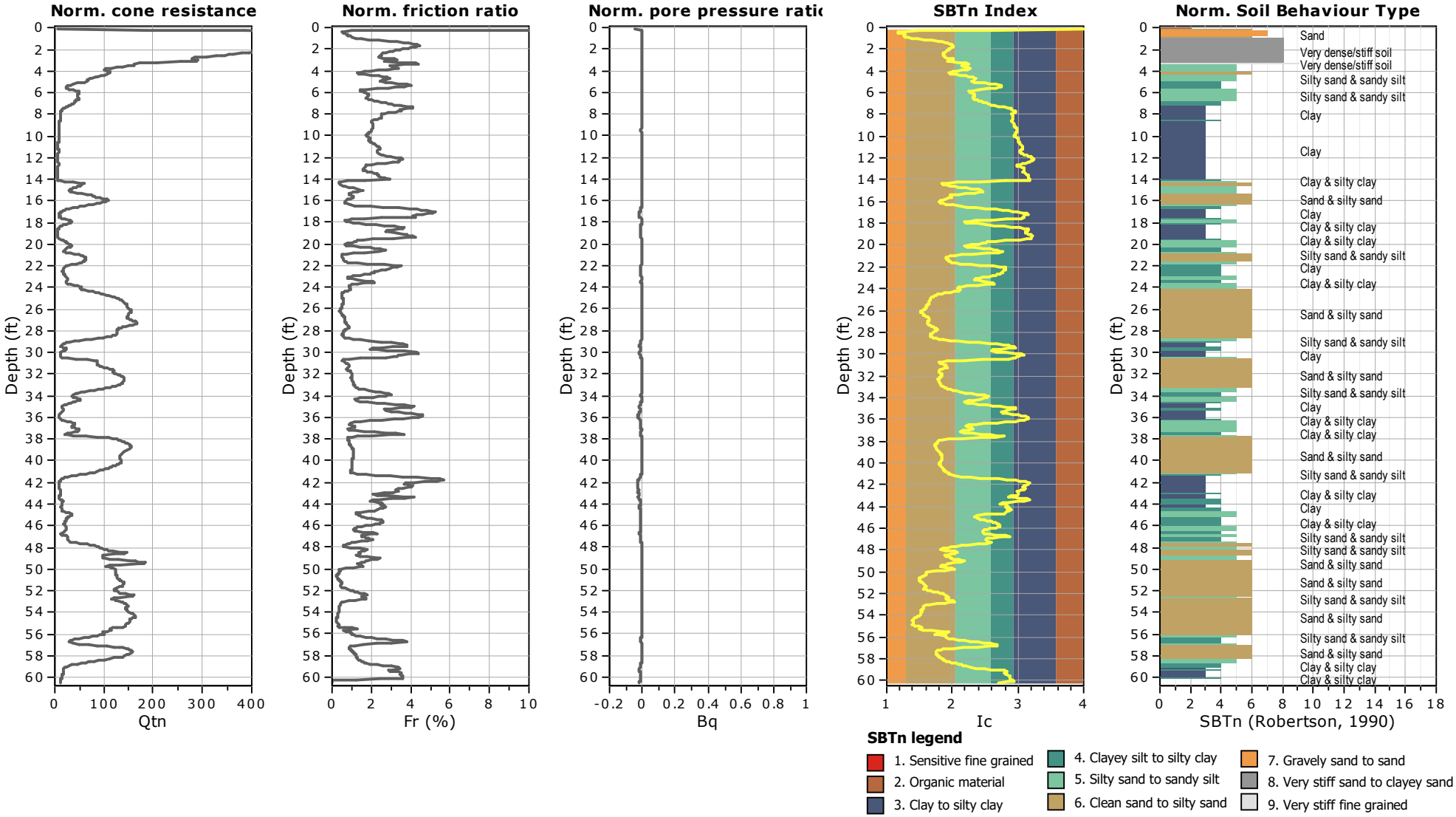
CPT: CPT-3A
Total depth: 60.52 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

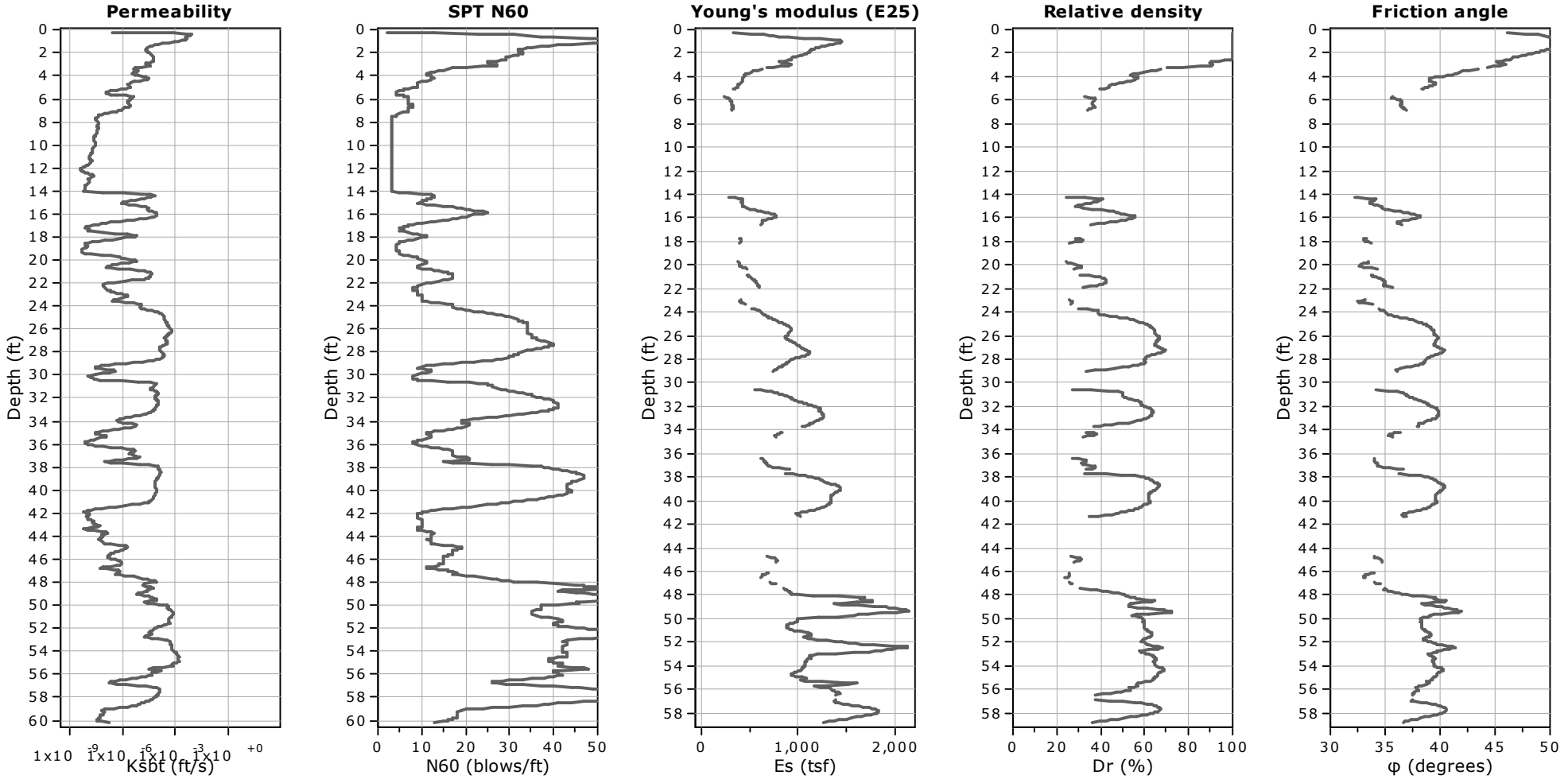
CPT: CPT-3A
Total depth: 60.52 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

CPT: CPT-3A
Total depth: 60.52 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**



Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Chrisian Wheeler Engineering
3980 Home Avenue
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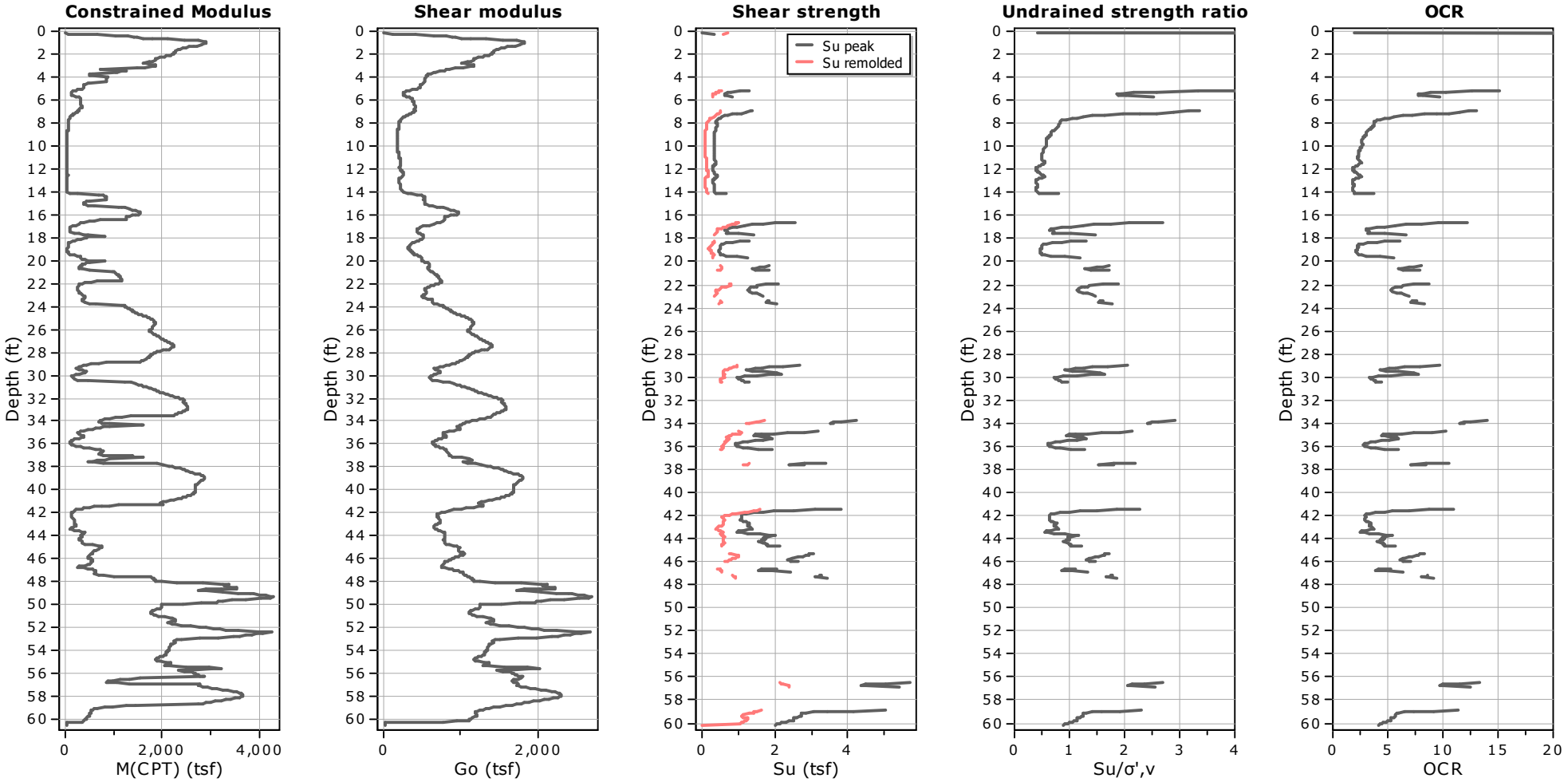
Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

CPT: CPT-3A
Total depth: 60.52 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Calculation parameters

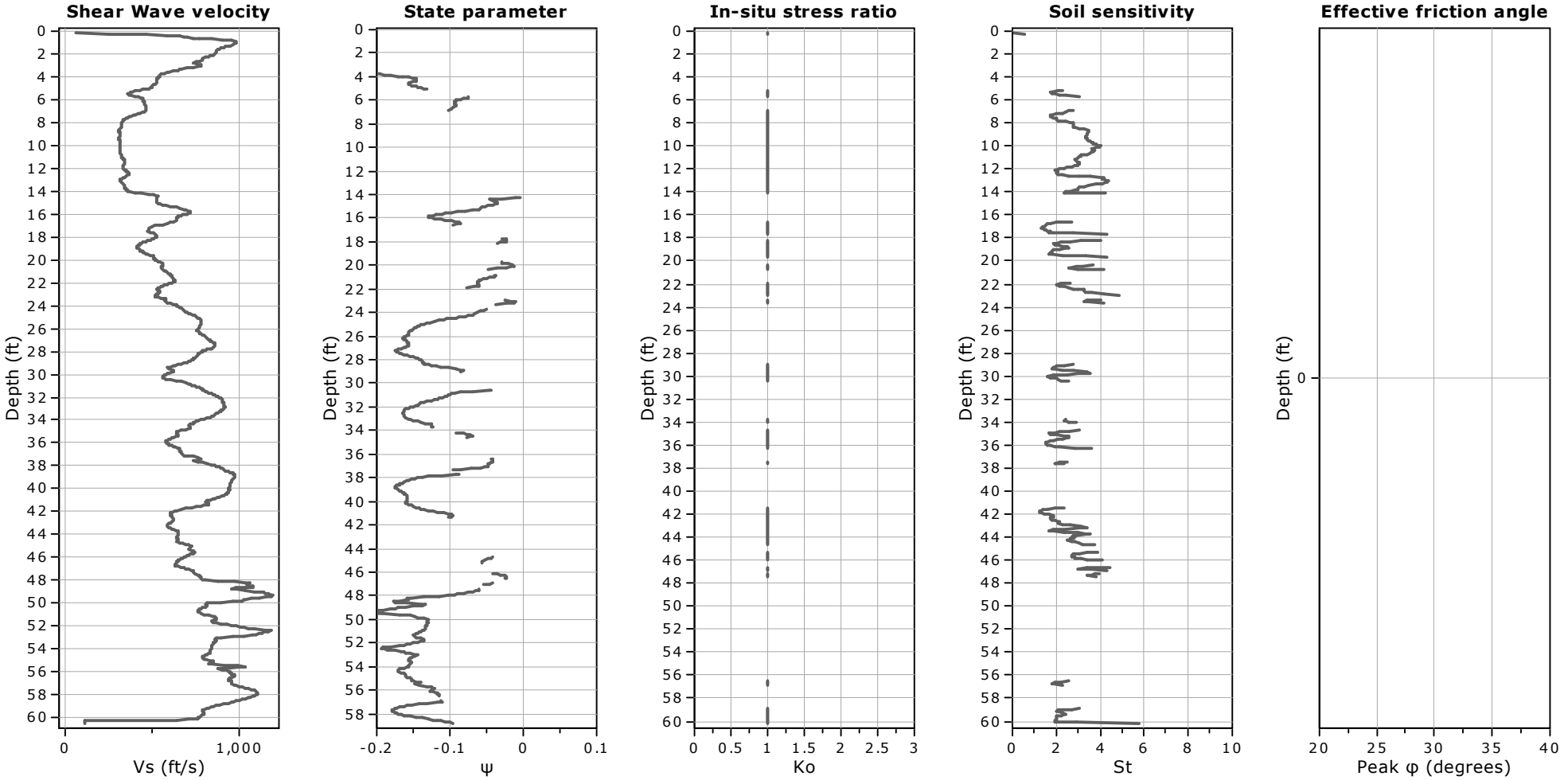
Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

CPT: CPT-3A
Total depth: 60.52 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



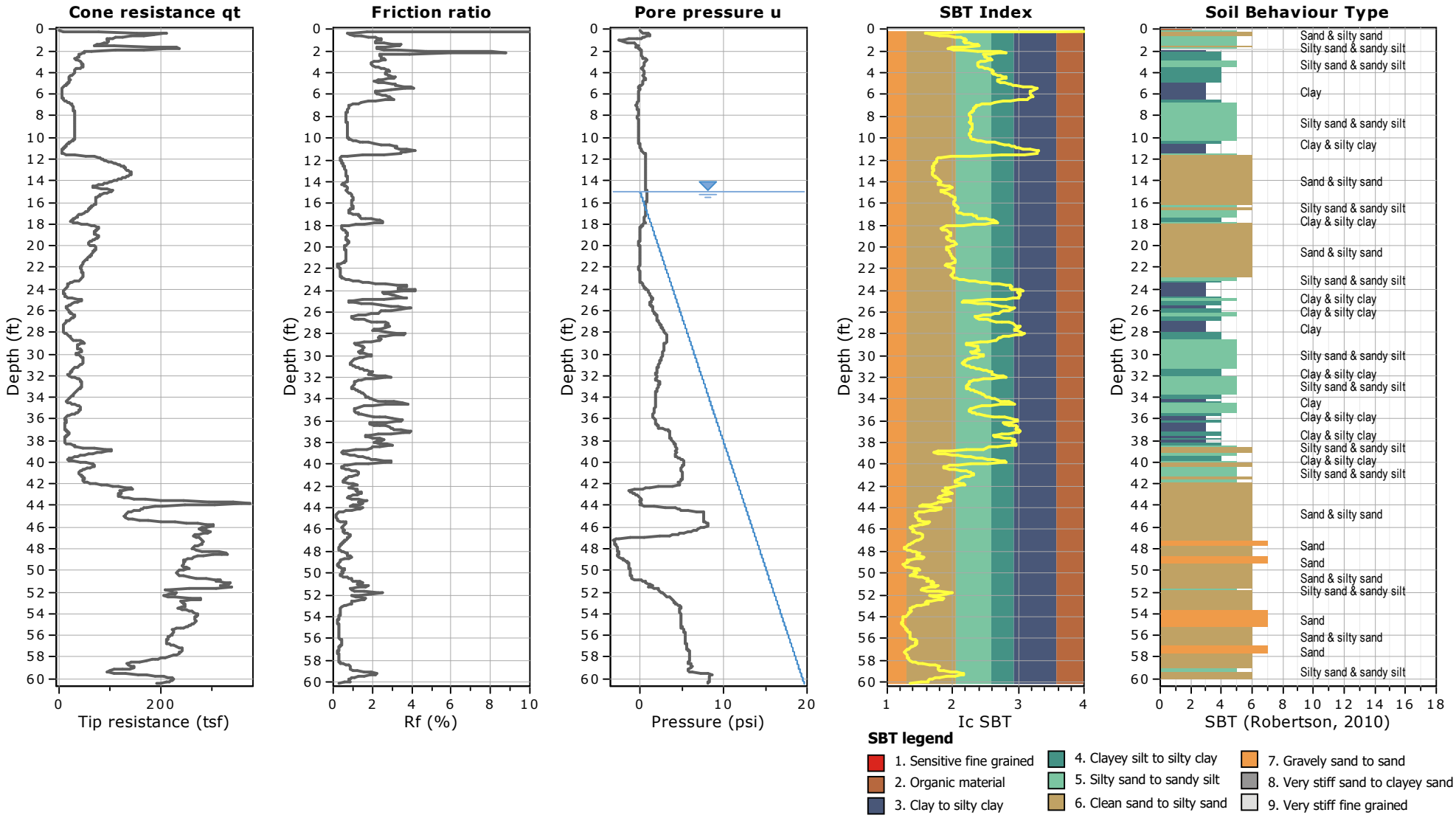
Calculation parameters

Soil Sensitivity factor, N_S: 7.00
User defined estimation data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

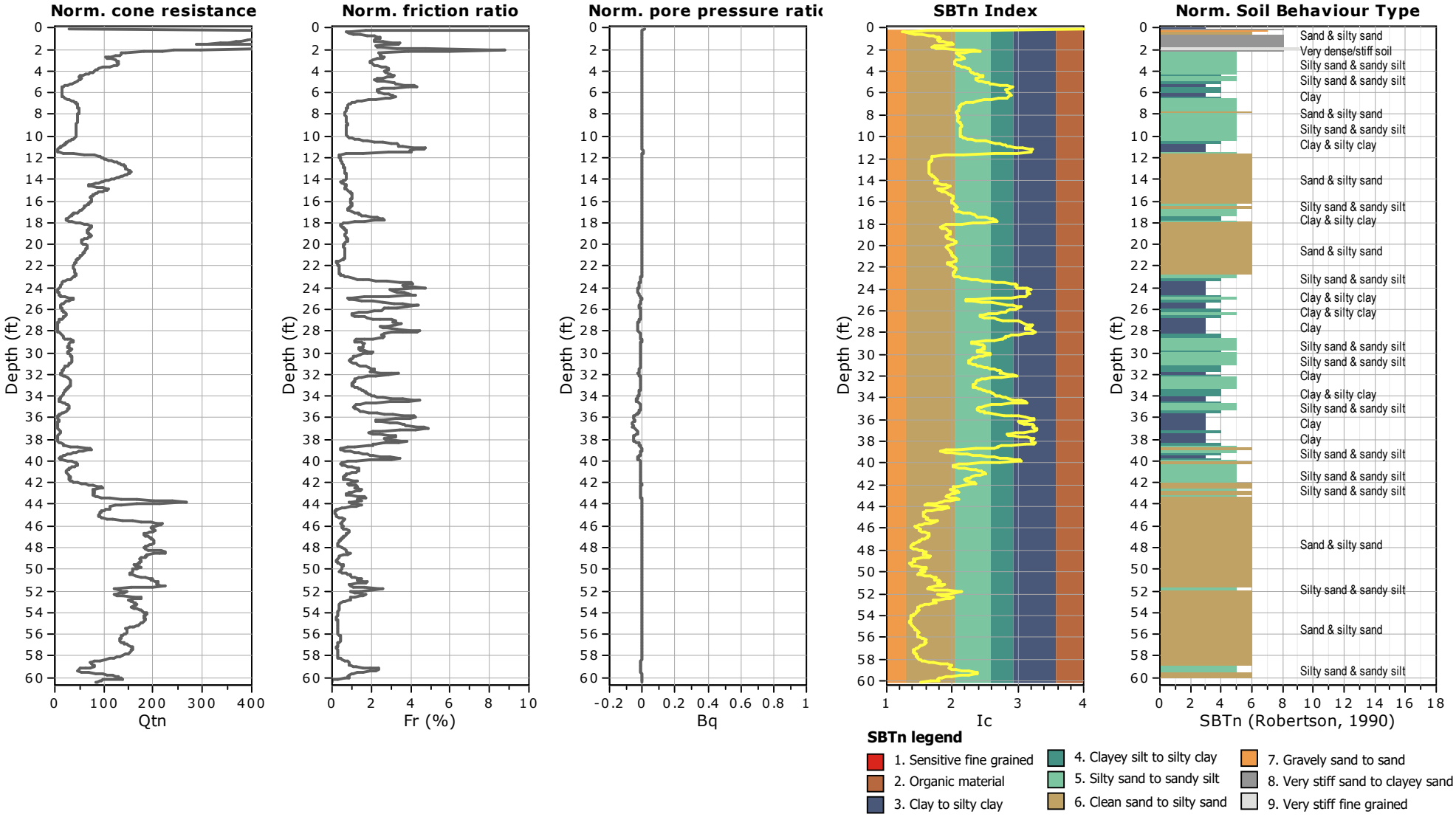
CPT: CPT-4
Total depth: 60.44 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

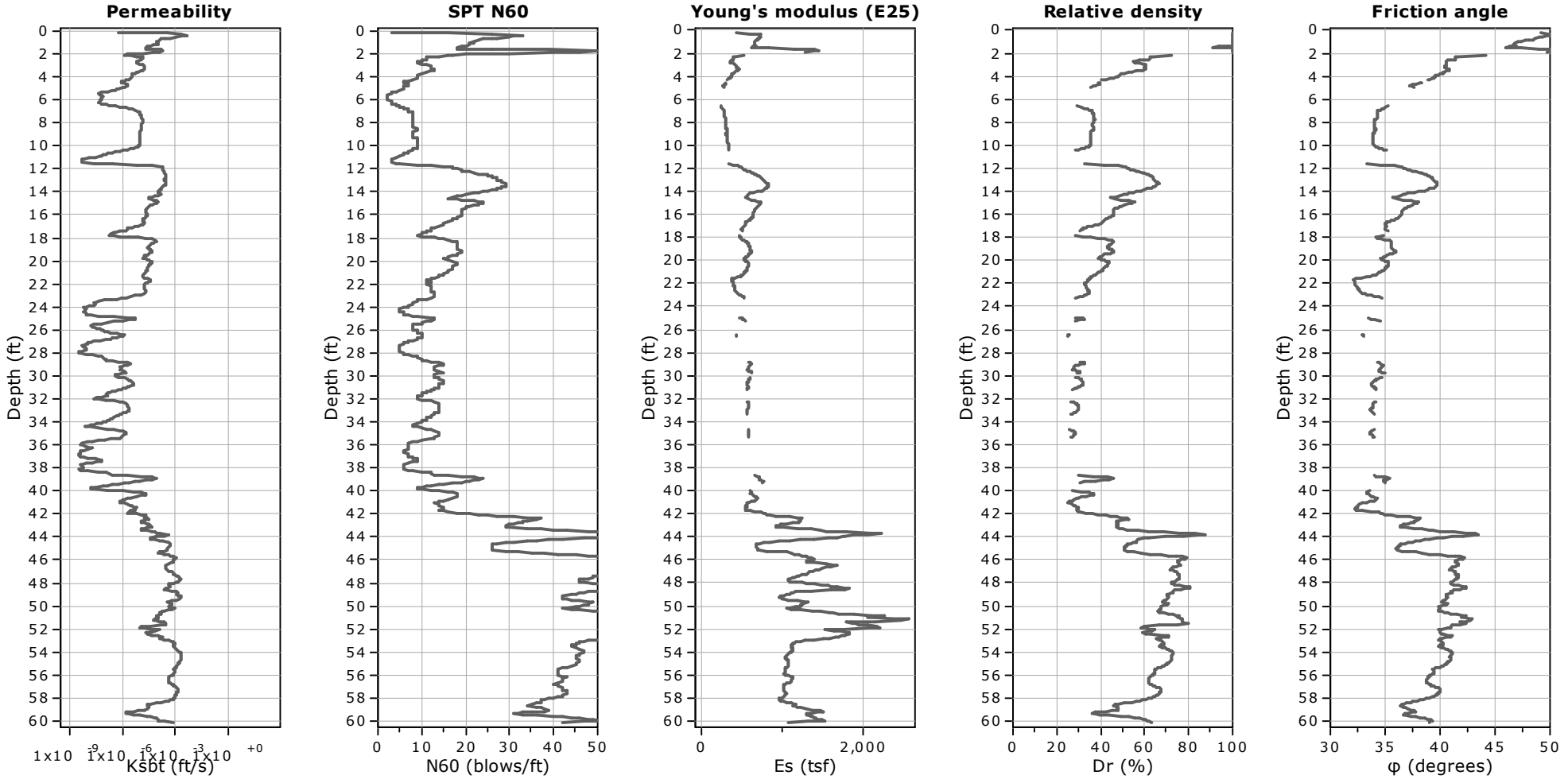
CPT: CPT-4
Total depth: 60.44 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

CPT: CPT-4
Total depth: 60.44 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**



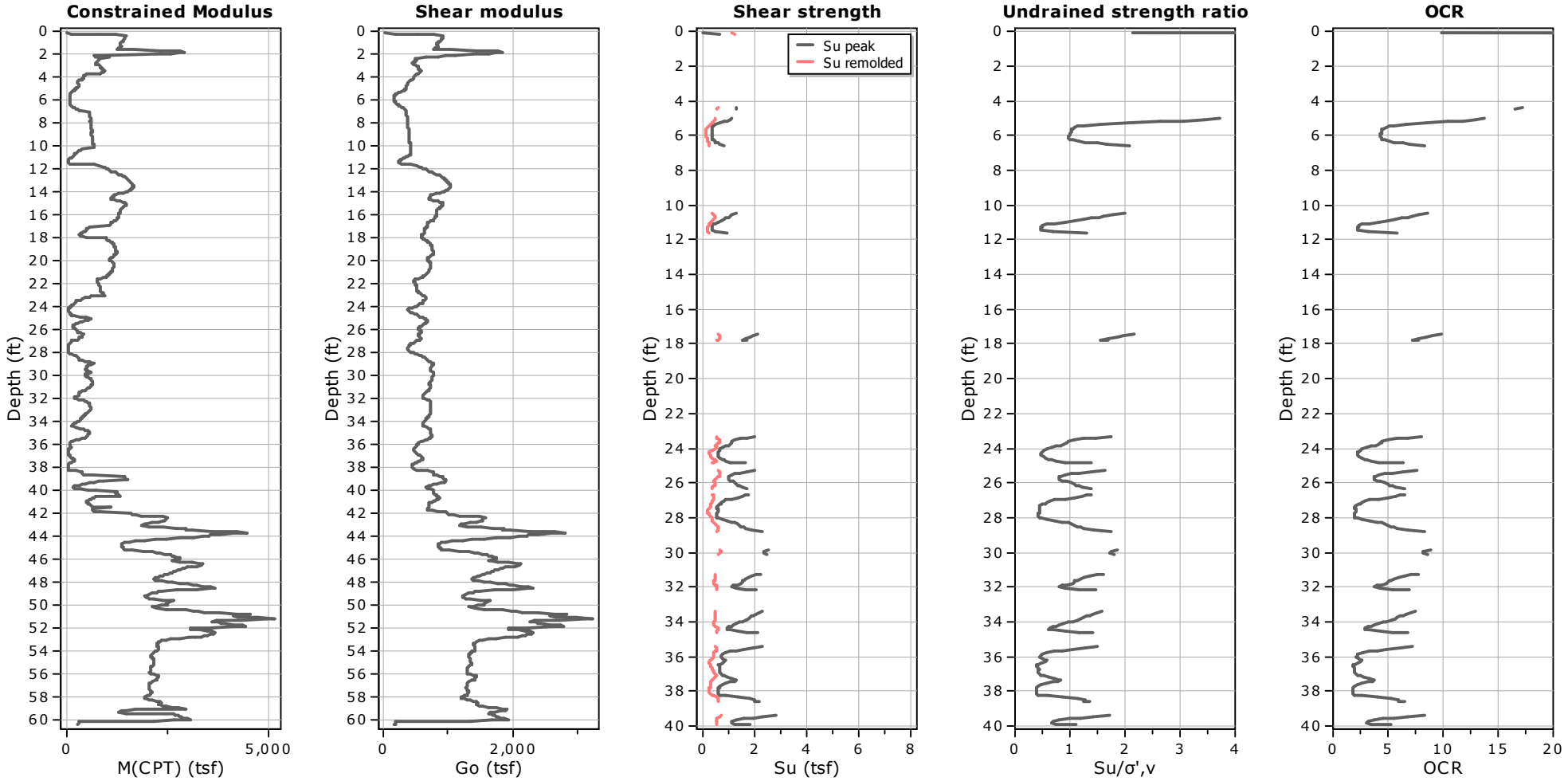
Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

CPT: CPT-4
Total depth: 60.44 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**



Calculation parameters

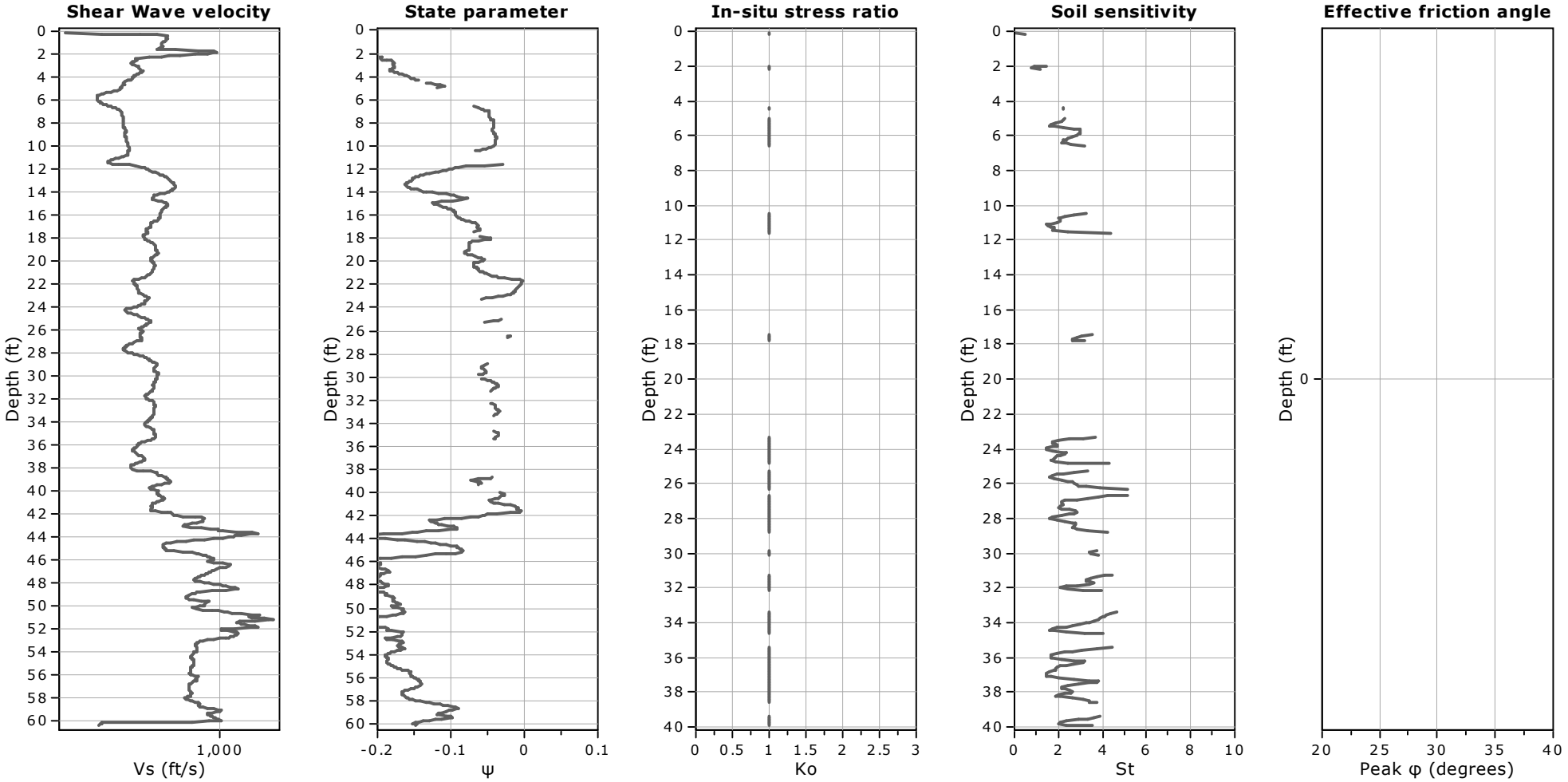
Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

CPT: CPT-4
Total depth: 60.44 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



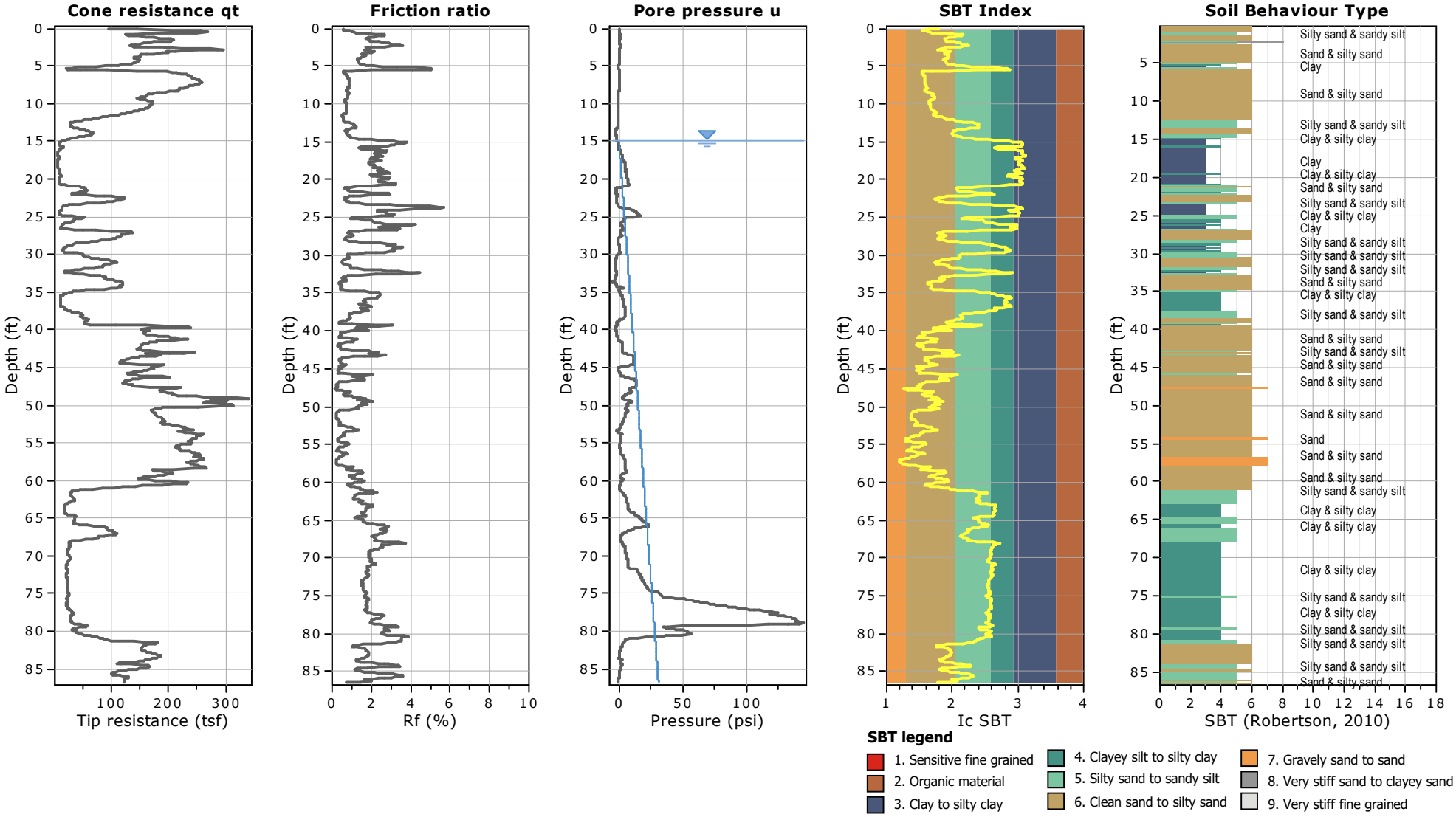
Calculation parameters

Soil Sensitivity factor, N_S: 7.00
User defined estimation data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

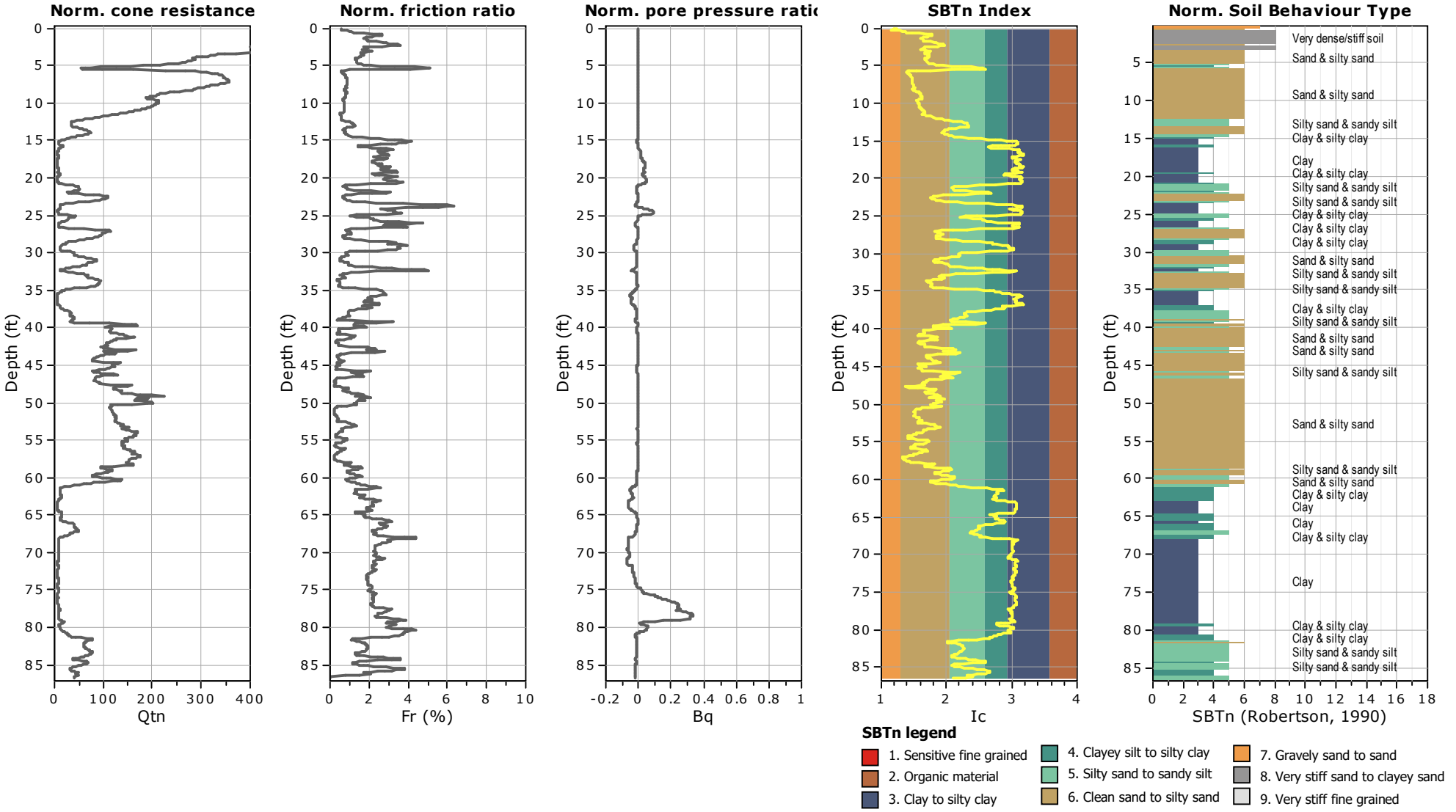
CPT: CPT-5
Total depth: 86.77 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

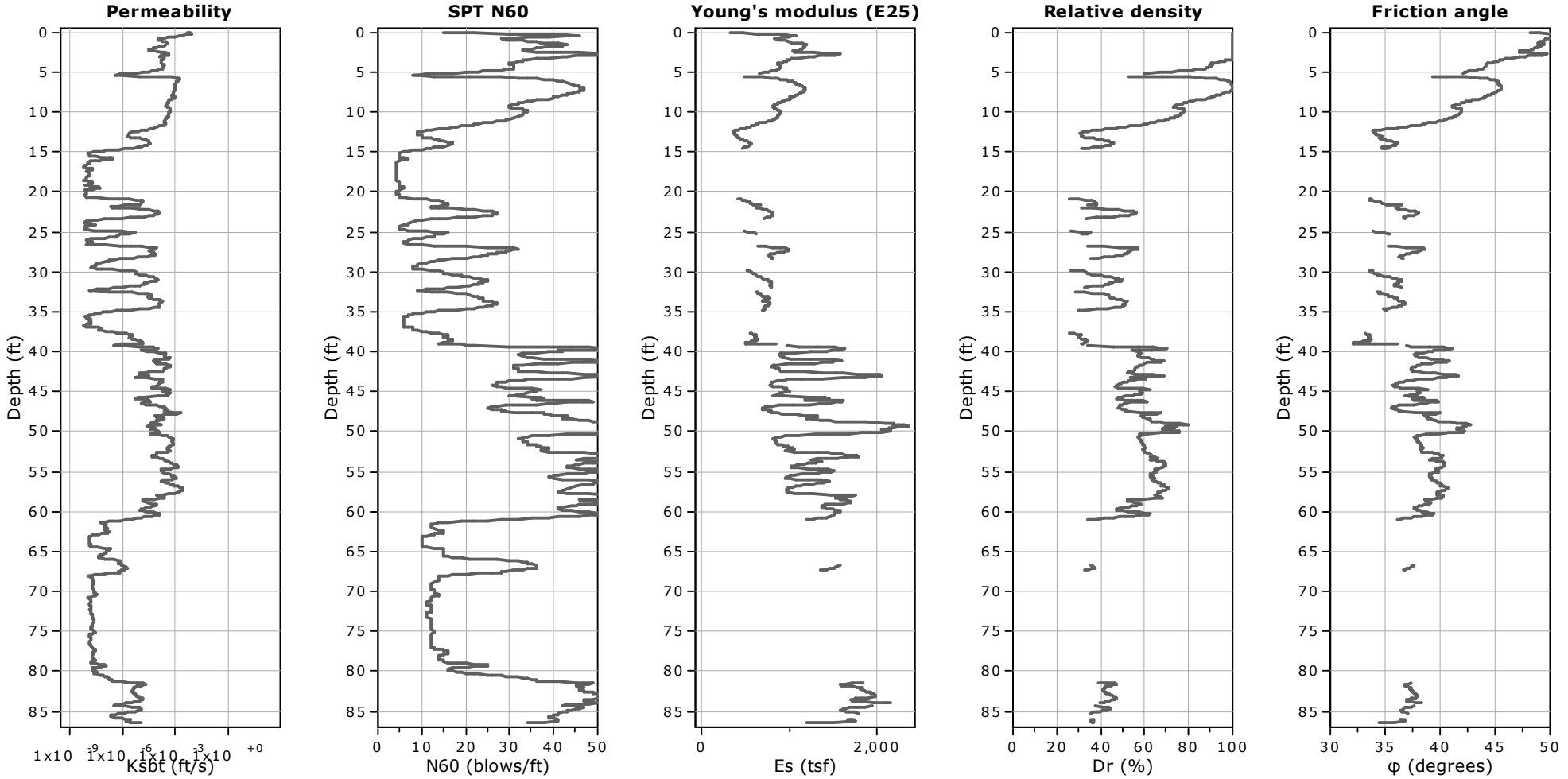
CPT: CPT-5
Total depth: 86.77 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

CPT: CPT-5
Total depth: 86.77 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**



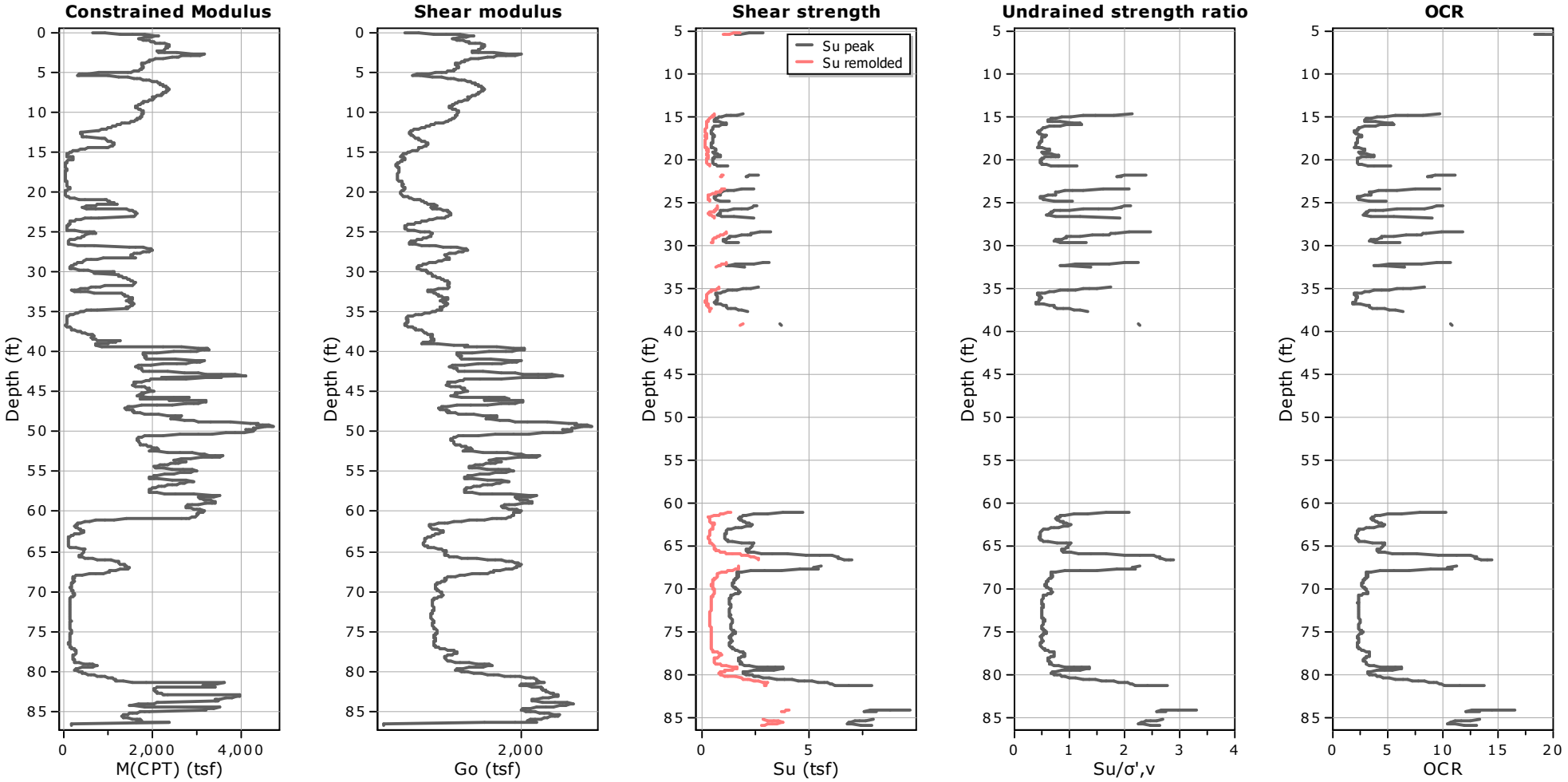
Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

CPT: CPT-5
Total depth: 86.77 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**



Calculation parameters

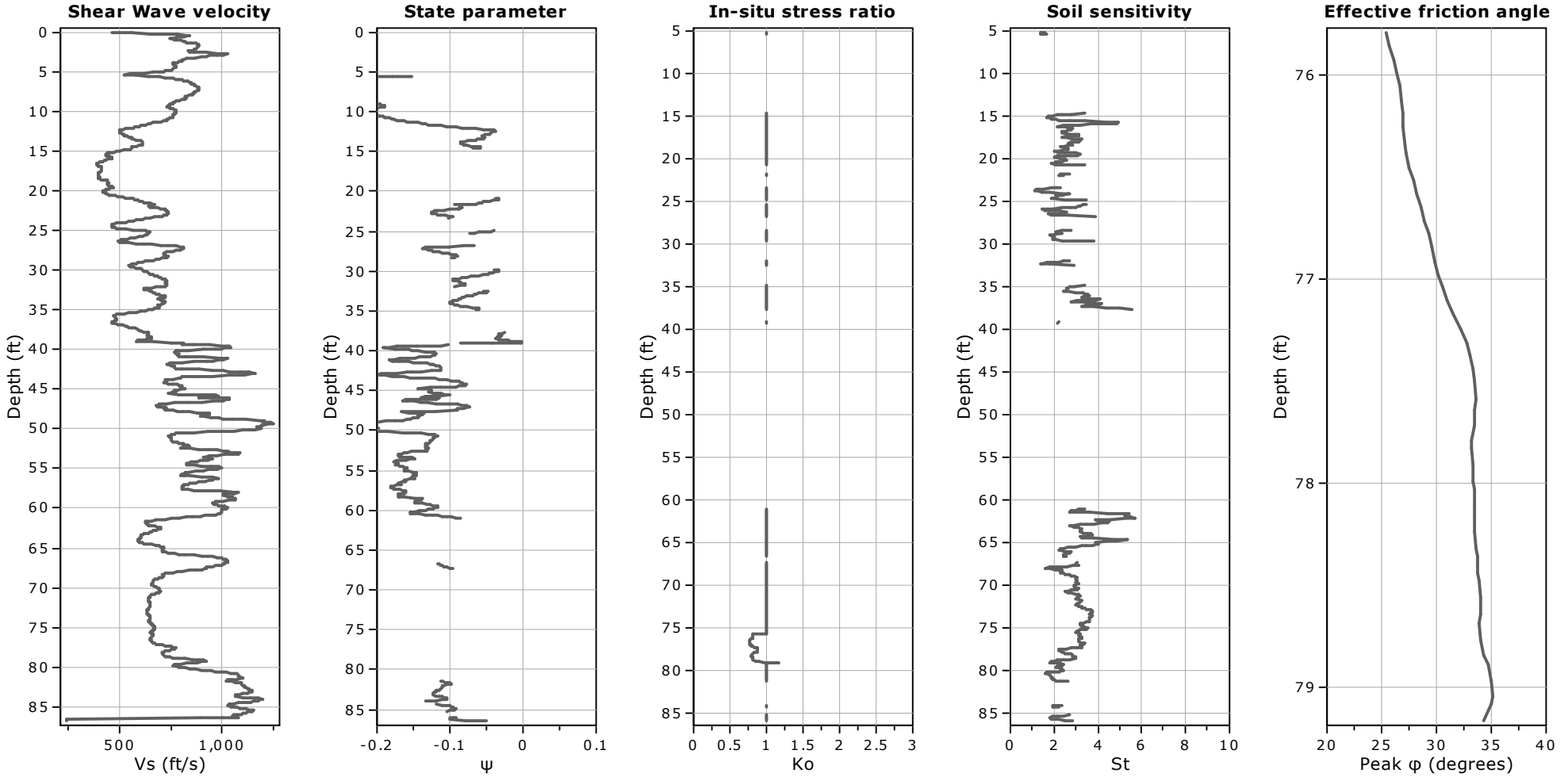
Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 0.33

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Chrisian Wheeler Engineering
3980 Home Avenue
San Diego, CA 92105

Project: **SWSD 2021**
Location: **SeaWorld, San Diego**

CPT: CPT-5
Total depth: 86.77 ft, Date: 4/2/2019
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing & Engineering



Calculation parameters

Soil Sensitivity factor, N_S: 7.00
User defined estimation data

Appendix B

Previous Exploration Logs and Laboratory Test Results

SUBSURFACE EXPLORATION LEGEND

UNIFIED SOIL CLASSIFICATION CHART

SOIL DESCRIPTION		GROUP SYMBOL	TYPICAL NAMES
I. COARSE GRAINED, more than half of material is larger than No. 200 sieve size.			
GRAVELS More than half of coarse fraction is larger than No. 4 sieve size but smaller than 3".	CLEAN GRAVELS	GW	Well graded gravels, gravel-sand mixtures, little or no fines.
		GP	Poorly graded gravels, gravel sand mixtures, little or no fines.
	GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
		GC	Clayey gravels, poorly graded gravel-sand, clay mixtures.
SANDS More than half of coarse fraction is smaller than No. 4 sieve size.	CLEAN SANDS	SW	Well graded sand, gravelly sands, little or no fines.
		SP	Poorly graded sands, gravelly sands, little or no fines.
	SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, poorly graded sand and silty mixtures.
		SC	Clayey sands, poorly graded sand and clay mixtures.
II. FINE GRAINED, more than half of material is smaller than No. 200 sieve size.			
SILTS AND CLAYS		ML	Inorganic silts and very fine sands, rock flour, sandy silt or clayey-silt-sand mixtures with slight plasticity.
	Liquid Limit less than 50	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty clays or low plasticity.
	SILTS AND CLAYS	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
	Liquid Limit greater than 50	CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity.
	HIGHLY ORGANIC SOILS	PT	Peat and other highly organic soils.

▽ — Water level at time of excavation or as indicated

US — Undisturbed, driven ring sample or tube sample

CK — Undisturbed chunk sample

BG — Bulk sample

SP — Standard penetration sample

SNR - Sample Not Retrieved

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

MISSION BERMUDA TRIANGLE EXHIBIT

BY: DBA	DATE: 05-11-93
JOB NUMBER: 9311068	Plate No. 2

BORING NUMBER 1

ELEVATION 20.5'

DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
0		SM	FILL, Brown and Grey SILTY SAND	Wet / Moist	Loose				
4	BG	ML	Grey VERY SANDY SILT	Moist	Soft to Medium Stiff				
6	US	SNR				7			
8		SP	Light Grey and Light Brown SAND	Humid to Moist	Medium Dense				
10	BG								
	US					28	98.2	3.8	
12	SP		Light Brown			21			
14			5.5' MSL ▽ Water Table	Wet					
16	US								
	SP	ML/SM	BAY MUDS, Dark Grey, VERY SANDY SILT/SANDY SILT	Saturated	Soft to Medium Stiff and Loose to Medium Dense	31 / 6	95.0	28.1	
20	US	SM/ML	SANDY SILT			5	81.8	41.3	
22	US	SM/ML				6			
24									
26	US	SM/ML				20	89.3	35.0	
28	SP	SM	VERY SILTY SAND		Loose to Medium Dense	9			
30									

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: CRB | DATE LOGGED: 03-31-93

JOB NUMBER: 9311068 | Plate No. 3

BORING NUMBER 1

ELEVATION 20.5'

DEPTH (ft)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
30	US	SM	Dark Grey VERY SILTY SAND	Saturated	Dense	35	103.7	27.4	
32	SP	SM				40			
34									
36	US	SM	Dark Grey VERY SILTY SAND		Dense	53	98.4	28.2	
	SP	SM				44			
38									
40	US	SM	Dark Grey SILTY SAND			88/11"	103.6	24.4	
42	SP	SM				38			
44									
46	US	SM			Very Dense	93	106.8	22.9	
	SP	SM				48			
48									
50			Boring Ended at 50' No Sample at 50' Due to Heaving Sands SNR=Sample Not Retrieved						

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: CRB | DATE LOGGED: 03-31-93

JOB NUMBER: 9311068 | Plate No. 4

BORING NUMBER 2

ELEVATION 21.5'

DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
0									
2		SM	FILL, Brown and Grey SILTY SAND	Moist	Loose to Medium Dense				
4									
6	US	SP	Brown SAND		Loose	19	112.3	8.9	
	SP	SP				4			
8									
			11.5' MSL						
10			▽ Water Table						
	US	SP		Saturated	Loose	11	92.1	29.5	
12	SP	SP				3			
14									
16	US	ML	BAY MUD, b ' Grey VERY SANDY SILT	Saturated	Stiff	6			
	SP					17			
18									
20	US	SM/ML	Dark Grey and Brown SILTY SAND/SANDY SILT and SAND		Medium Dense	27	103.2	26.8	
22	SP	SM/SP				17			
24									
26	US	SM	Grey SILTY SAND			17	87.1	36.2	
	SP	SM				24			
28									
30									

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: CRB | DATE LOGGED: 03-31-93

JOB NUMBER: 9311068 | Plate No. 5

BORING NUMBER 2

ELEVATION 21.5'

DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
30	US	SM	Grey SILTY SAND	Saturated	Medium Dense	30	86.3	37.5	
32									
34									
36	SP	SM	Grey SILTY SAND			14			
38									
40	US	SM	Grey SILTY SAND			31	93.6	32.4	
42									
14					?				
46	US	SM	Grey SILTY SAND		Medium Dense to Dense	74/11"	103.8	32.8	
48									
50	SP	SM	Grey SILTY SAND			48			
52			Boring Ended at 51.5'						

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: CRB	DATE LOGGED: 03-31-93
JOB NUMBER: 9311068	Plate No. 6

BORING NUMBER 3

ELEVATION 22'

DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
0	BG	SM/ML	FILL, Dark Brown SANDY SILT/SILTY SAND	Very Moist	Loose				
2		SC/CL &	Tan to Light Brown CLAYEY SAND/SANDY CLAY and SILTY SAND, Some Gravel	Very Moist	Medium Dense and Stiff				
4	BG								
6	US					40	116.1	14.7	
	SP					35			
8	BG	SM& ML	Dark Grey to Grey Brown SILTY SAND with some SANDY SILT Layers	Very Moist	Loose to Med Dense and Med Stiff				
10	US					20	107.2	15.6	
12	SP	ML& SM	Dark Grey Brown SANDY SILT with some SILTY SAND Layers	Very Moist to Wet	Soft and Loose				
14			▽ 8'MSL Water Table						
16	US	SP/SM	Grey SLIGHTLY SILTY SAND, Some Gravel	Saturated	Medium Dense	25	110.3	15.9	
18	SP					13			
20	US	SM/ML	BAY MUDS, Dark Grey Interbedded SILTY SAND and SANDY SILT with some CLAYEY SILT, SILTY CLAY and SAND Layers	Saturated	Loose to Med Dense and Soft to Med Stiff	10			
22	SP					11			
24			— — — SNR						
26	US		SNR			10			
	SP					8			
28									
30									

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: MF | DATE LOGGED: 04-01-93

JOB NUMBER: 9311068 | Plate No. 7

BORING NUMBER 3

ELEVATION 22'

DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
30	US	SM& ML	Dark Grey Interbedded SILTY AND and SANDY SILT with some CLAYEY SILT, SILTY CLAY and SAND Layers	Saturated	Loose to Med Dense and Soft to Med Stiff	10	71.3	52.5	
32	SP					11			
34									
36	US		SNR		Medium Dense and Very Stiff	52			
	SP					28			
38									
40	US		SNR			30	96.8	26.3	
42	SP					50/6"			
46	US		SNR			43			
	SP					50/6"			
48									
50	US		SNR			50/6"			
52	SP					60/5"			
			Boring Ended at 52.5'						

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: MF | DATE LOGGED: 04-01-93

JOB NUMBER: 9311068 | Plate No. 8

BORING NUMBER 4

ELEVATION 27.5'

DEP. (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
0		SM/ SP	FILL, Brown SLIGHTLY SILTY SAND	Moist	Medium Dense				
2	BG								
4									
6	US					40			
	SP					10			
8									
10		SP	Light Grey SAND with Shell Fragments	Humid	Medium Dense				
	US					24	96.5	6.8	
12	BG SP					20			
			13.5' MSL ▽ Water Table						
	US	SP/ SM	Grey to Grey Brown SLIGHTLY SILTY SAND, Some Shell Fragments	Saturated	Medium Dense	49	96.3	30.2	
16									
	SP		SNR, Rock?			23			
18									
20		SM& ML	BAY MUDS, Dark Grey Interbedded SILTY SAND and SANDY SILT, Occasional CLAYEY SILT, SILTY CLAY and SAND Layers	Saturated	Loose to Med Dense and Soft to Medium Stiff				
	US					12	95.6	30.6	
22	SP					8			
24									
	US		SANDY SILT More Common			9	85.7	37.2	
26									
28									
30									

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: MF	DATE LOGGED: 04-01-93
JOB NUMBER: 9311068	Plate No. 9

BORING NUMBER 4

ELEVATION 27.5'

DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
30	US	SM& ML	Dark Grey Interbedded SILTY SAND and SANDY SILT, Occasional CLAYEY SILT, SILTY CLAY and SANDY Layers	Saturated	Medium Dense	27	102.9	25.9	
32	SP					25			
34									
36	US					26	98.9	29.7	
38	SP					15			
40	US					47	102.3	26.6	
42	SP					24			
44									
46	US					41	104.9	24.8	
48	SP					20			
50	US		SNR			73/11"			
52	SP					50/6"			
			Boring Ended at 52.5'						

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: MF | DATE LOGGED: 04-01-93

JOB NUMBER: 9311068 | Plate No. 10

BORING NUMBER 5

ELEVATION 26.5'

DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
0			Concrete over Base						
2	BG	SM	FILL, Yellow Brown SILTY SAND	Moist	Medium Dense				
4									
6	SP		3" Asphaltic Concrete over Base			34			
8	BG	SM	Dark Grey Brown SILTY SAND	Moist	Medium Dense to Dense				
10		SW	Yellow Brown SAND	Humid to Moist	Medium Dense	42			
12	SP BG								
14			12.5' MSL ▽ Water Table	Saturated	Loose				
16									
18		CL	BAY MUDS, Dark Grey SILTY CLAY	Saturated	Soft				
20	SP					6			
22	SP	SM	Grey SILTY SAND	Saturated	Loose to MedDense	5			
24		ML & CL	Dark Grey Interbedded CLAYEY SILT, SANDY SILT and SILTY CLAY	Saturated	Soft				
26	SP					3			
28		ML & SM	Dark Grey Interbedded SANDY SILT and SILTY SAND	Saturated	Loose & Medium Stiff				
30									

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: MF | DATE LOGGED: 04-07-93

JOB NUMBER: 9311068 | Plate No. 11

BORING NUMBER 5

ELEVATION 26.5'

DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
30									
32	SP	ML & SM	Dark Grey Interbedded SANDY SILT and SILTY SAND, Some CLAYEY SILT and SILTY CLAY Layers	Saturated	Loose and Medium Stiff	10			
34		SM	Dark Grey SILTY SAND, Some CLAYEY SILT and SAND Layers	Saturated	Medium Dense				
36	SP					38			
38									
40									
42	SP					12			
44									
46	SP					18			
48									
50	SP					28			
52			Boring Ended at 51'						

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: MF | DATE LOGGED: 04-07-93

JOB NUMBER: 9311068 | Plate No. 12

BORING NUMBER 6

ELEVATION 22.5'

DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
0		SM	FILL, Dark Brown SILTY SAND	Moist	Loose				
2	BG	SM& ML	Dark Grey Brown SANDY SILT and SILTY SAND	Very Moist	Soft and Loose				
4	BG	ML, CL& SC	Dark Grey CLAYEY SILT, SILTY CLAY and VERY CLAYEY SAND	Wet to Saturated	Soft	2/6"	68.3	53.8	
6	US	SP/ SM	Yellow Brown SLIGHTLY SILTY SAND, Minor Gravel	Moist	Loose to Medium Dense	6/6"			
8		SP	Grey SAND	Moist	Medium Dense				
10	US		13.5' MSL ▽ Water Table	Saturated		18	98.3	23.2	
12		ML& CL	BAY MUDS, Dark Grey CLAYEY SILT and SILTY CLAY, Some SILTY SAND Layers	Saturated	Soft				
16	US					5	78.9	47.3	
18		ML& SM	Dark Grey SANDY SILT and SILTY SAND	Saturated	Loose to Dense and Medium Stiff				
20	US					11	85.1	39.7	
24									
26	US					12			
28		SM	Grey SILTY SAND, Some CLAYEY SILT, SANDY SILT and SAND Layers	Saturated	Medium Dense				
30									

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: MF | DATE LOGGED: 04-07-93

JOB NUMBER: 9311068 | Plate No. 13

BORING NUMBER 6

ELEVATION 22.5'

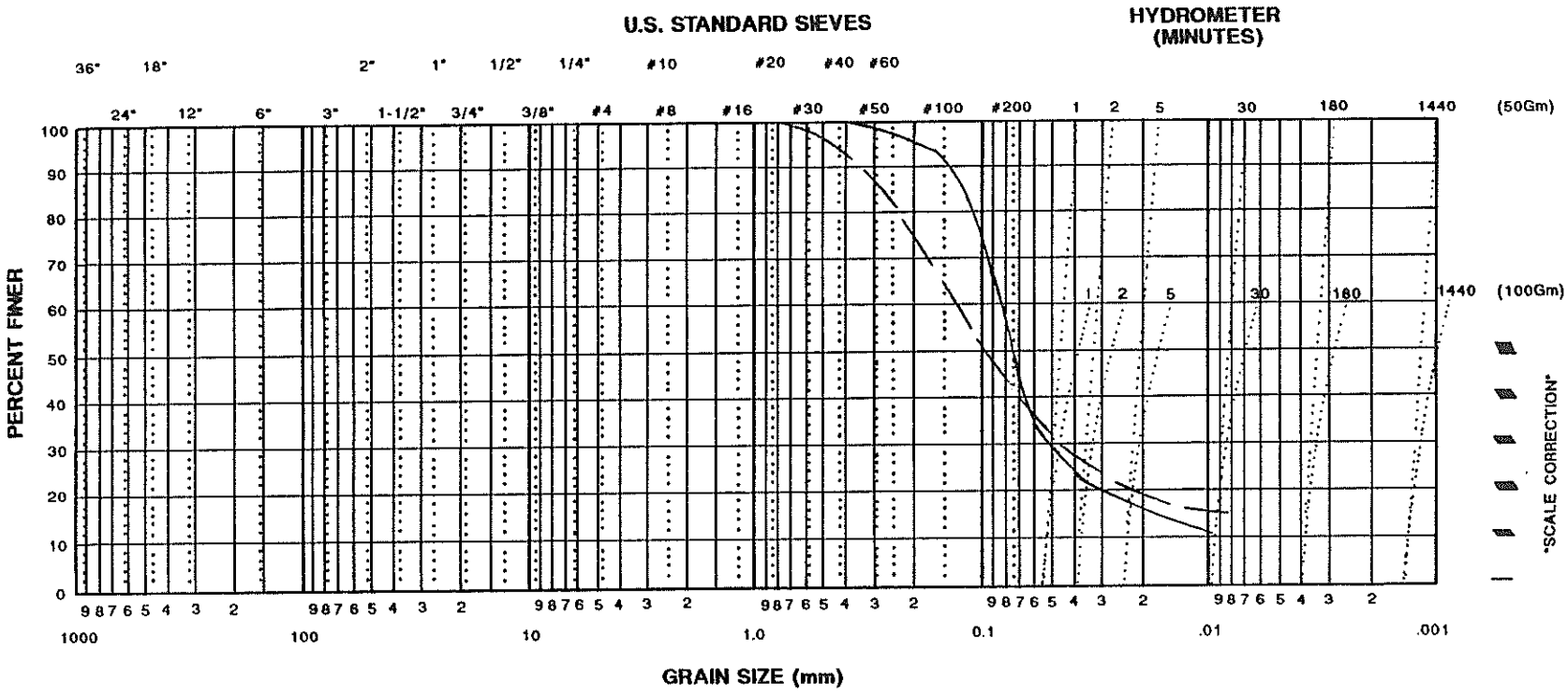
DEPTH (ft.)	SAMPLE TYPE	SOIL CLASSIFICATION	DESCRIPTION	APPARENT MOISTURE	APPARENT CONSISTENCY OR DENSITY	PENETRATION RESISTANCE (blows/ft. of drive)	DRY DENSITY (pcf)	MOISTURE CONTENT (%)	RELATIVE COMPACTION (%)
30	US	SM	Grey SLIGHTLY SILTY SAND, Some SANDY SILT, CLAYEY SILT and SAND Layers	Saturated	Medium Dense	19	100.3	26.8	
32									
34									
36	US					15	94.7	31.1	
38									
40	US					41?	110.0	22.2	
42			Boring Ended at 41'						

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

SUBSURFACE EXPLORATION LOG

LOGGED BY: MF | DATE LOGGED: 04-07-93

JOB NUMBER: 9311068 | Plate No. 14



PARTICLE SIZE LIMITS

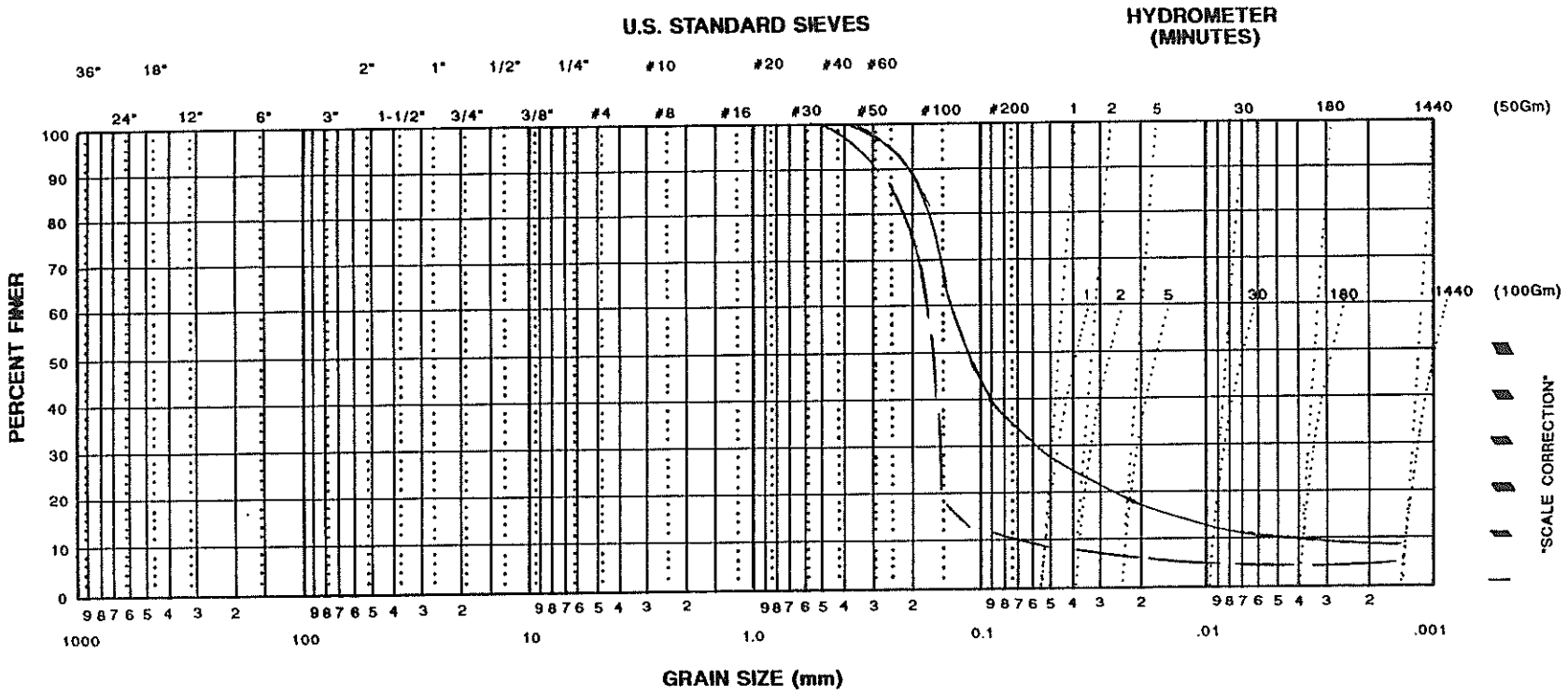
BOULDER	COBBLE	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	
(12")		3"	3/4"	No. 4	No. 10	No. 40	No. 200

U.S. STANDARD SIEVE SIZE

——— B1@ 16.5'-17.5'
— — B1@ 28'-29'

PROJECT: MISSION BERMUDA TRIANGLE EXHIBIT
DATE: 05-11-93
BY: DBA
JOB NUMBER: 9311068
Plate No. 15

SOUTHERN CALIFORNIA SOIL AND TESTING



PARTICLE SIZE LIMITS

BOULDER	COBBLE	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	
(12")	3"	3/4"		No. 4	No. 10	No. 40	No. 200

U.S. STANDARD SIEVE SIZE

——— B1@ 36.5'-37.5'

— — B2@ 22'-22.5'

PROJECT: MISSION BERMUDA TRIANGLE EXHIBIT

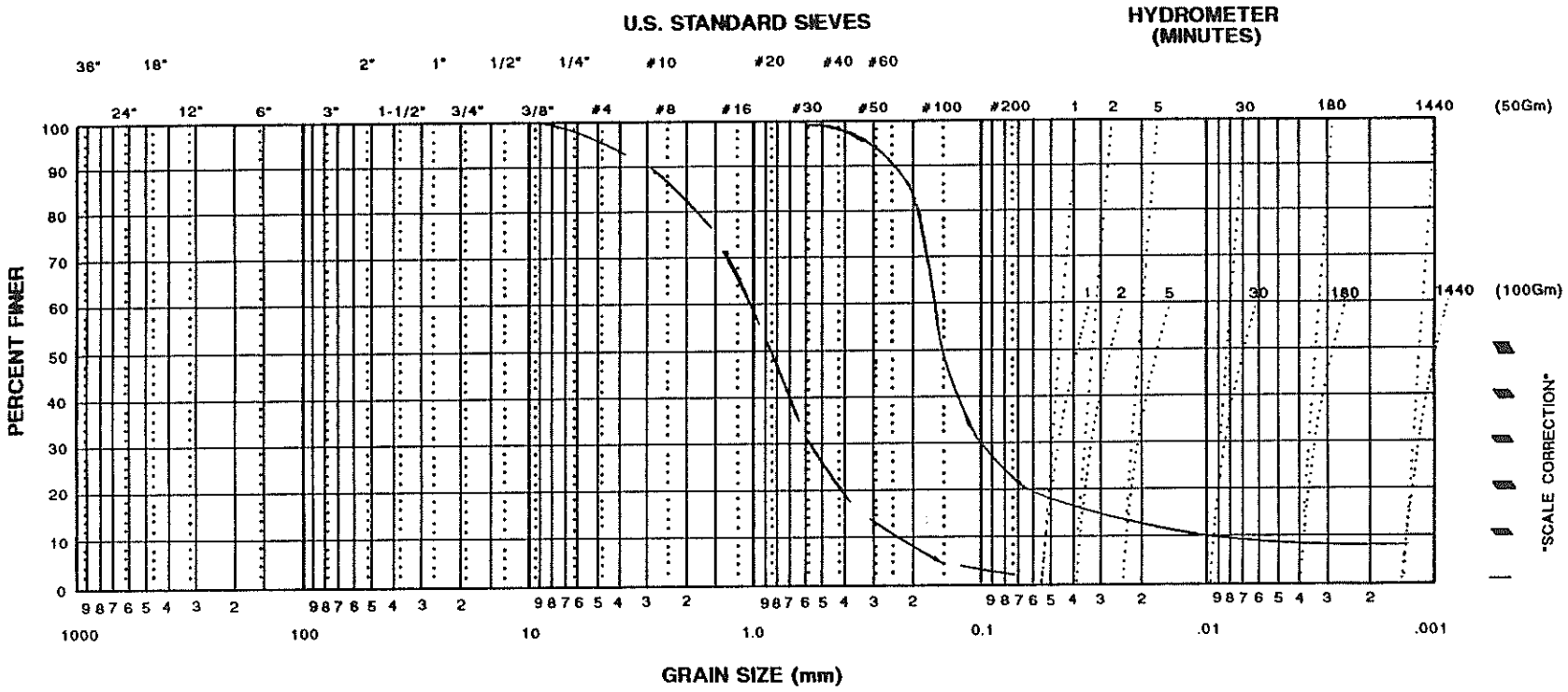
DATE: 05-11-93

BY: DBA

JOB NUMBER: 9311068

Plate No. 16

SOUTHERN CALIFORNIA SOIL AND TESTING



PARTICLE SIZE LIMITS

BOULDER	COBBLE	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	
(12")		3"	3/4"	No. 4	No. 10	No. 40	No. 200

U.S. STANDARD SIEVE SIZE

——— B2@ 35.5'-36.5'

— — B5@ 15'-16.5'

SOUTHERN CALIFORNIA SOIL AND TESTING

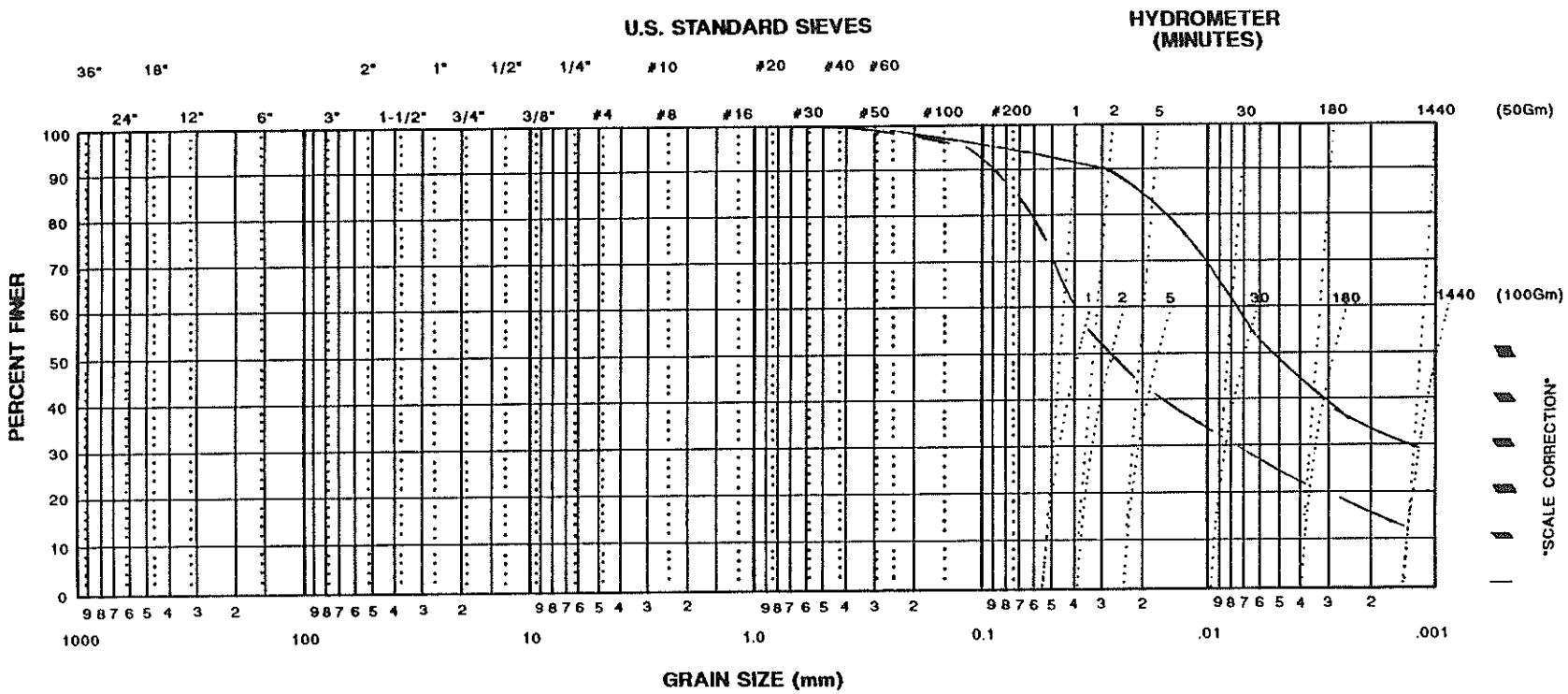
PROJECT: MISSION BERMUDA TRIANGLE EXHIBIT

BY: DBA

DATE: 05-11-93

JOB NUMBER: 9311068

Plate No. 17



PARTICLE SIZE LIMITS

BOULDER	COBBLE	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	
(12")		3"	3/4"	No. 4	No. 10	No. 40	No. 200

U.S. STANDARD SIEVE SIZE

——— B5@ 20'-21'

—— —— B5@ 25'-26'

PROJECT: MISSION BERMUDA TRIANGLE EXHIBIT

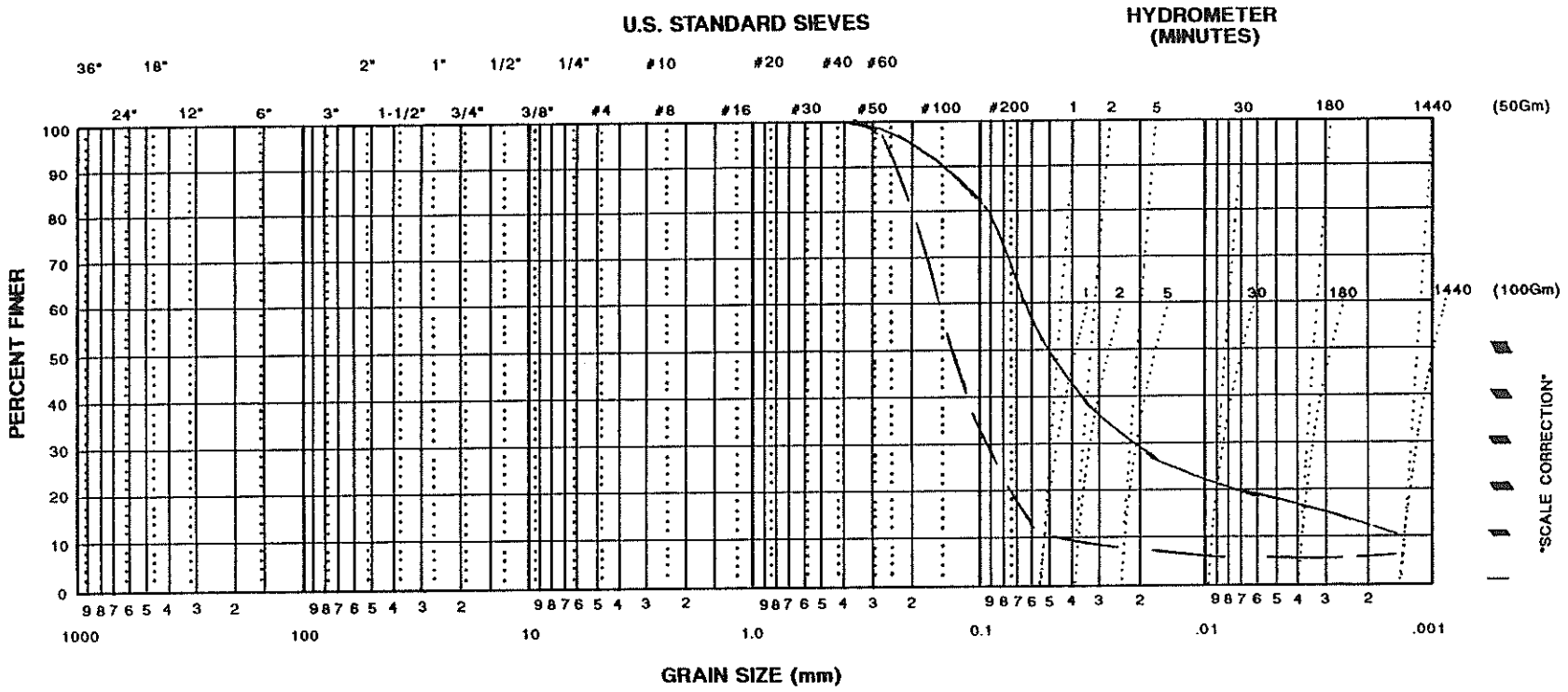
DATE: 05-11-93

BY: DBA

JOB NUMBER: 9311068

Plate No. 18

SOUTHERN CALIFORNIA SOIL AND TESTING



PARTICLE SIZE LIMITS

BOULDER	COBBLE	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	
	(12")	3"	3/4"	No. 4	No. 10	No. 40	No. 200

U.S. STANDARD SIEVE SIZE

——— B5@ 30'-31.5'

— — — B5@ 35'-36.5'

PROJECT: MISSION BERMUDA TRIANGLE EXHIBIT

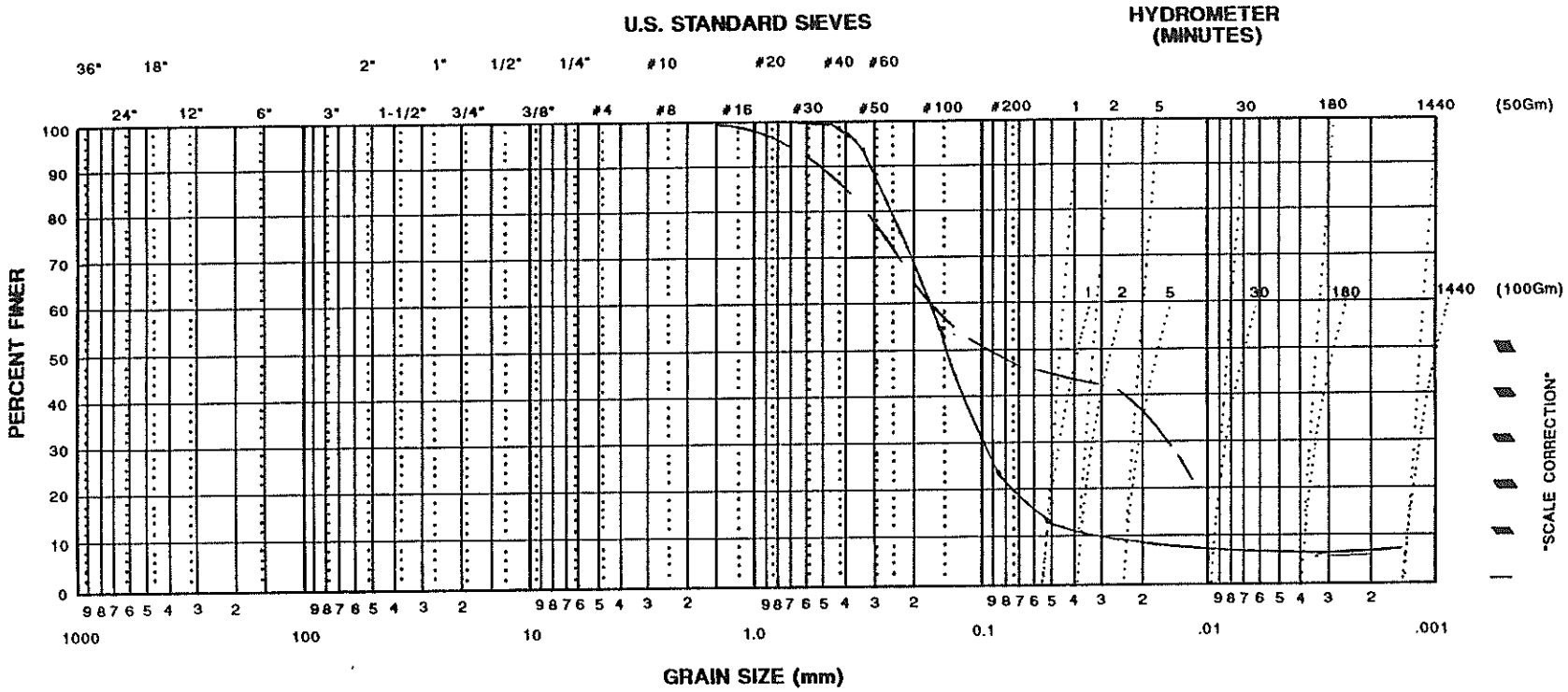
DATE: 05-11-93

BY: DBA

JOB NUMBER: 9311068

Plate No. 19

SOUTHERN CALIFORNIA SOIL AND TESTING



PARTICLE SIZE LIMITS

BOULDER	COBBLE	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	
(12")		3"	3/4"	No. 4	No. 10	No. 40	No. 200

U.S. STANDARD SIEVE SIZE

B5@ 45'-46.5'

B6@ 1'-3'

PROJECT: MISSION BERMUDA TRIANGLE EXHIBIT

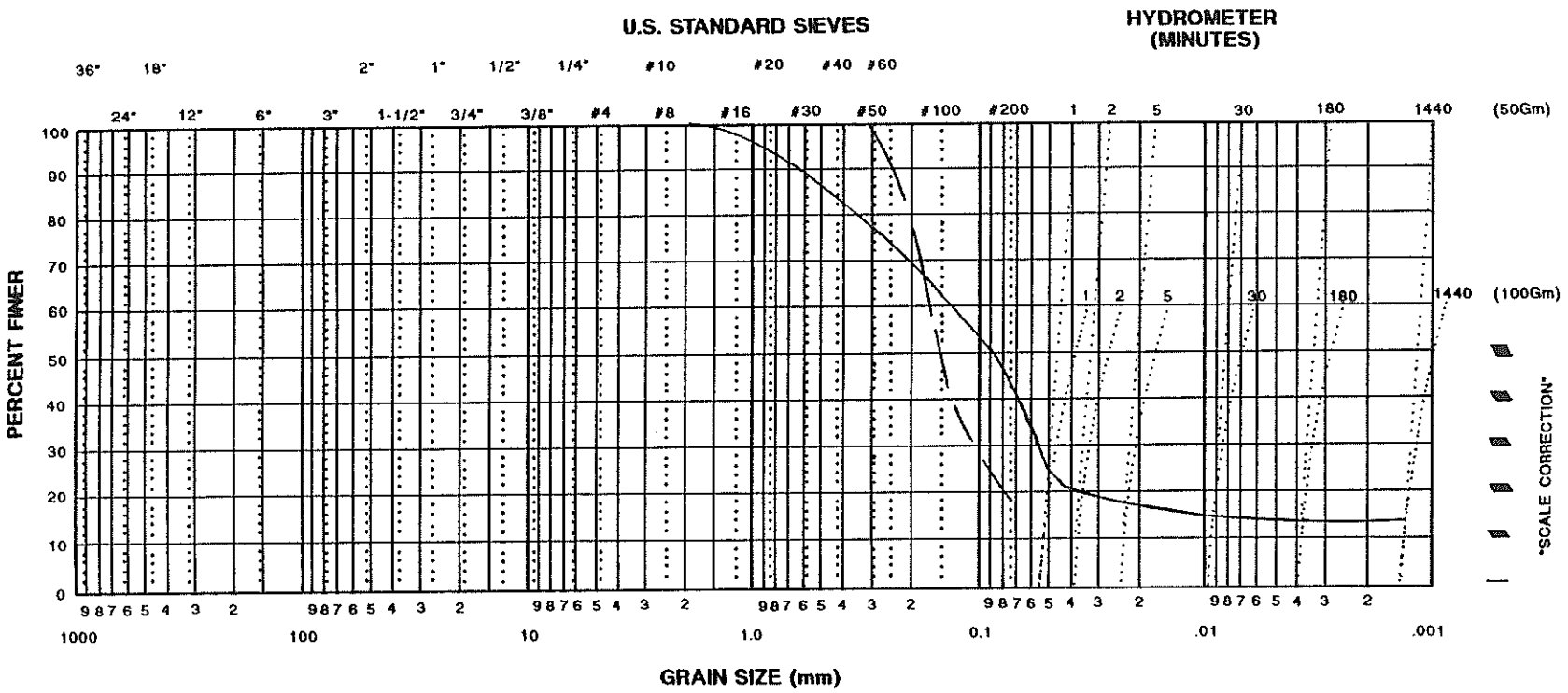
DATE: 05-11-93

BY: DBA

JOB NUMBER: 9311068

Plate No. 20

SOUTHERN CALIFORNIA SOIL AND TESTING



PARTICLE SIZE LIMITS

BOULDER	COBBLE	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	
(12")		3"	3/4"	No. 4	No. 10	No. 40	No. 200

U.S. STANDARD SIEVE SIZE

——— B6@ 3.5'-5'

—— —— B6@ 30'-30.5'

PROJECT: MISSION BERMUDA TRIANGLE EXHIBIT

DATE: 05-11-93

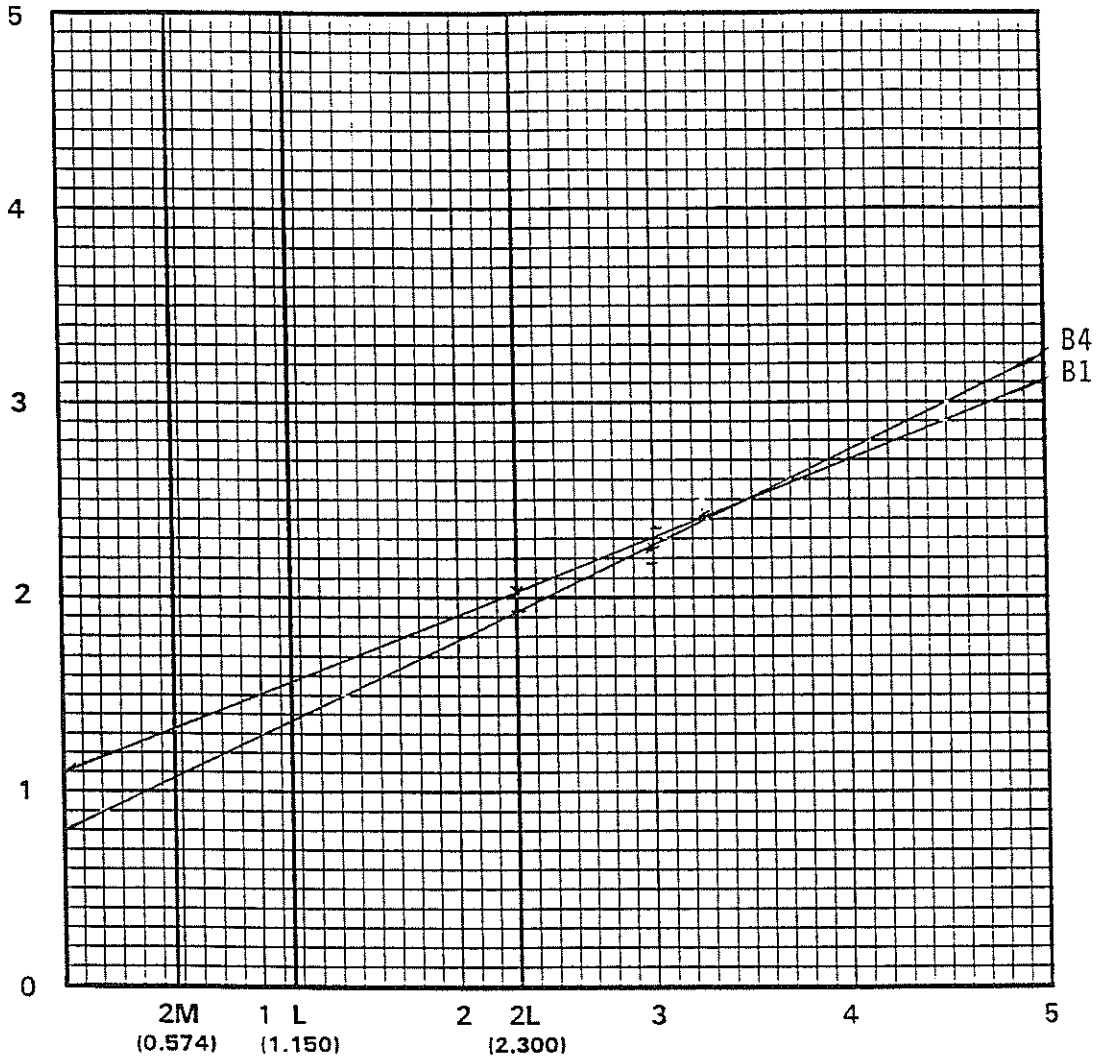
BY: DBA

JOB NUMBER: 9311068

Plate No. 21

SOUTHERN CALIFORNIA SOIL AND TESTING

DIRECT SHEAR SUMMARY



SAMPLE	DESCRIPTION	ANGLE OF INTERNAL FRICTION	COHESION INTERCEPT (PSF)
B1 - 36' to 46' Shear Profile	Undisturbed	23	1100
B4 - 36' to 46' Shear Profile	Undisturbed	27	800

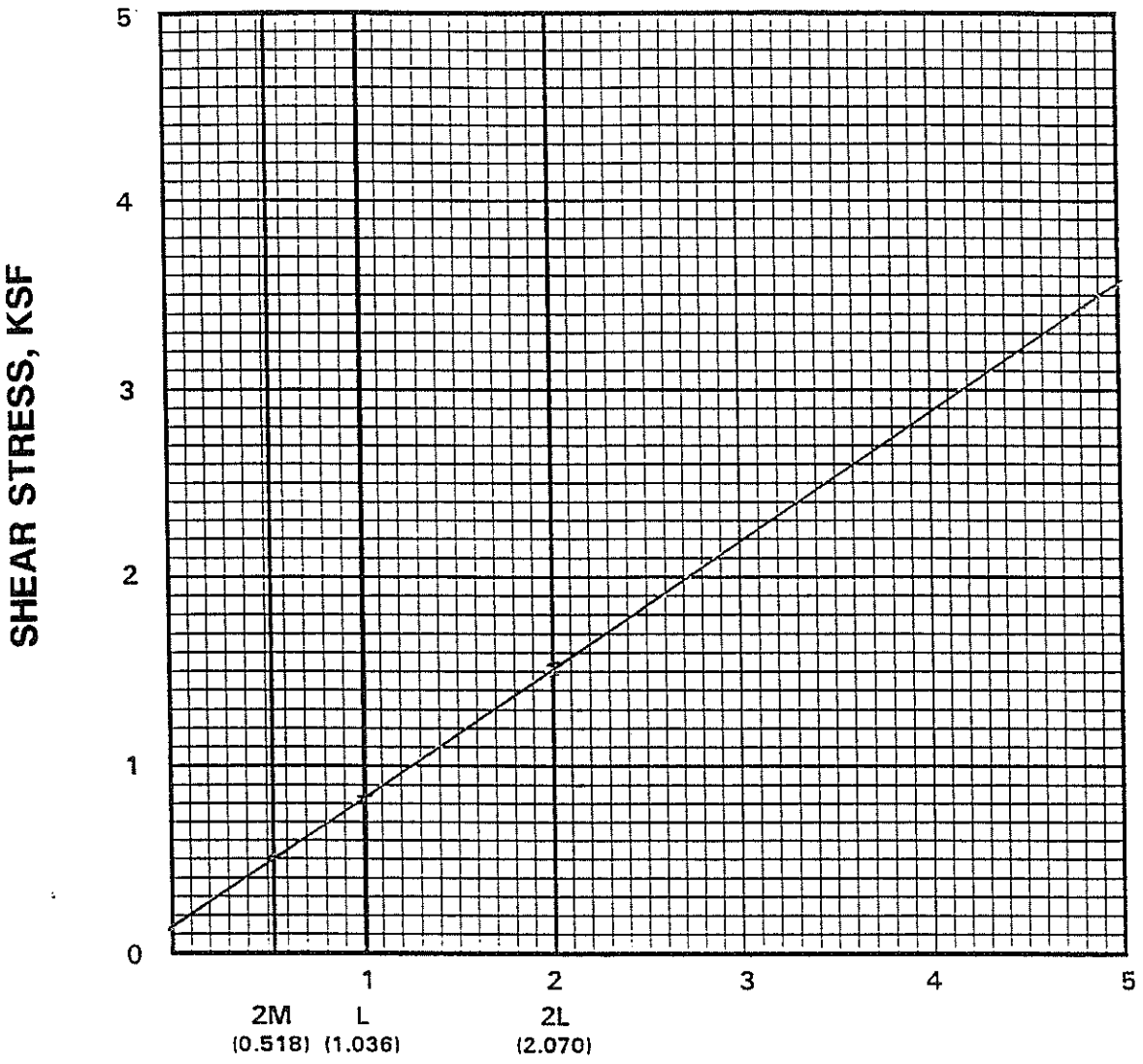
PROVING RING No. _____

SOUTHERN CALIFORNIA SOIL & TESTING, INC.

MISSION BERMUDA TRIANGLE EXHIBIT

BY: DBA	DATE: 05-11-93
JOB NUMBER: 9311068	PLATE No.: 22

DIRECT SHEAR SUMMARY



SAMPLE	DESCRIPTION	ANGLE OF INTERNAL FRICTION	COHESION INTERCEPT (PSF)
B6@ 1'-3'	Remolded to 90%	34	150

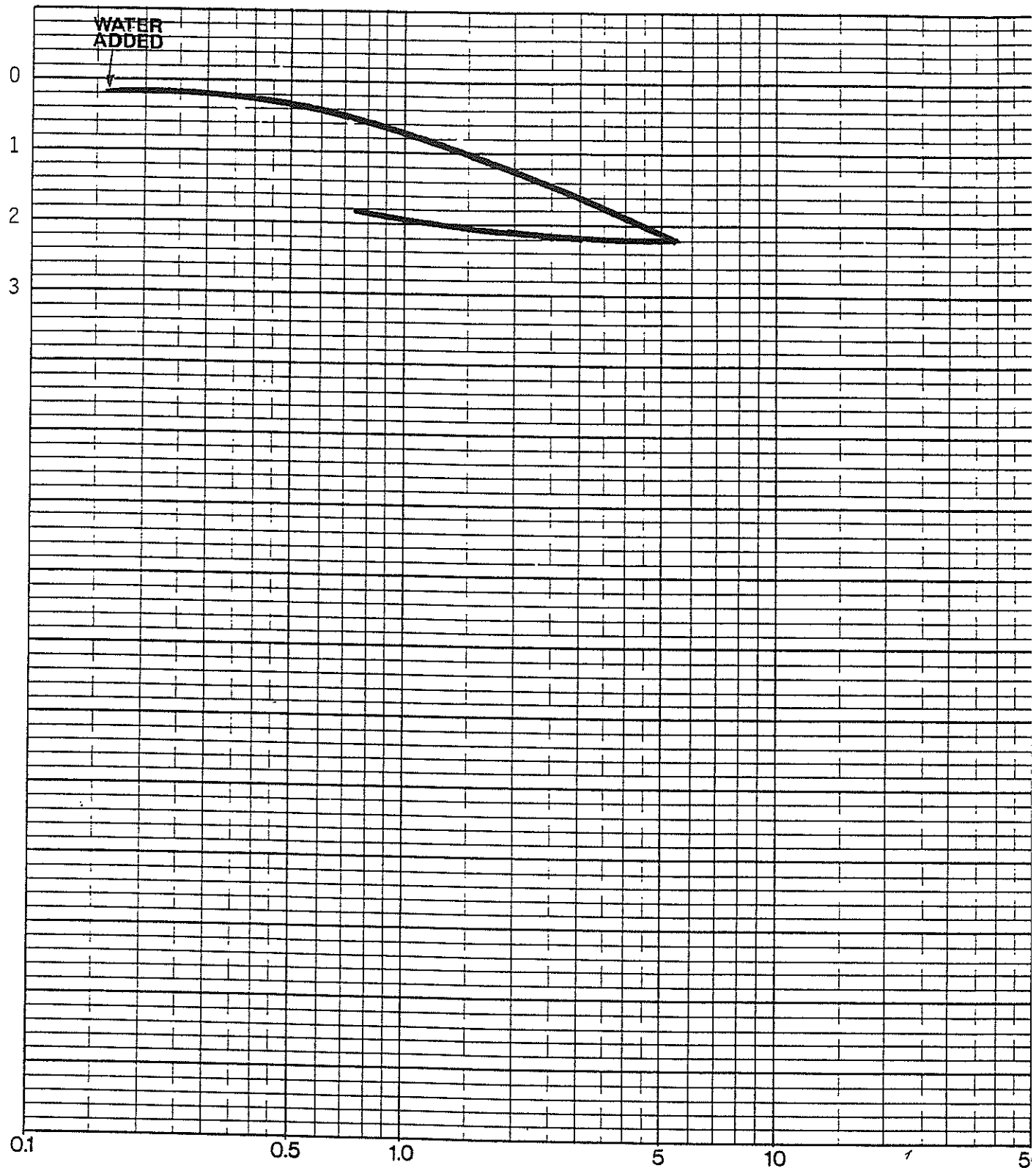
PROVING RING No. _____

SOUTHERN CALIFORNIA
SOIL & TESTING, INC.

MISSION BERMUDA TRIANGLE EXHIBIT

BY: DBA	DATE: 05-11-93
JOB NUMBER: 9311068	PLATE No.: 23

SHEAR28-A-91



CONSOLIDATION percent

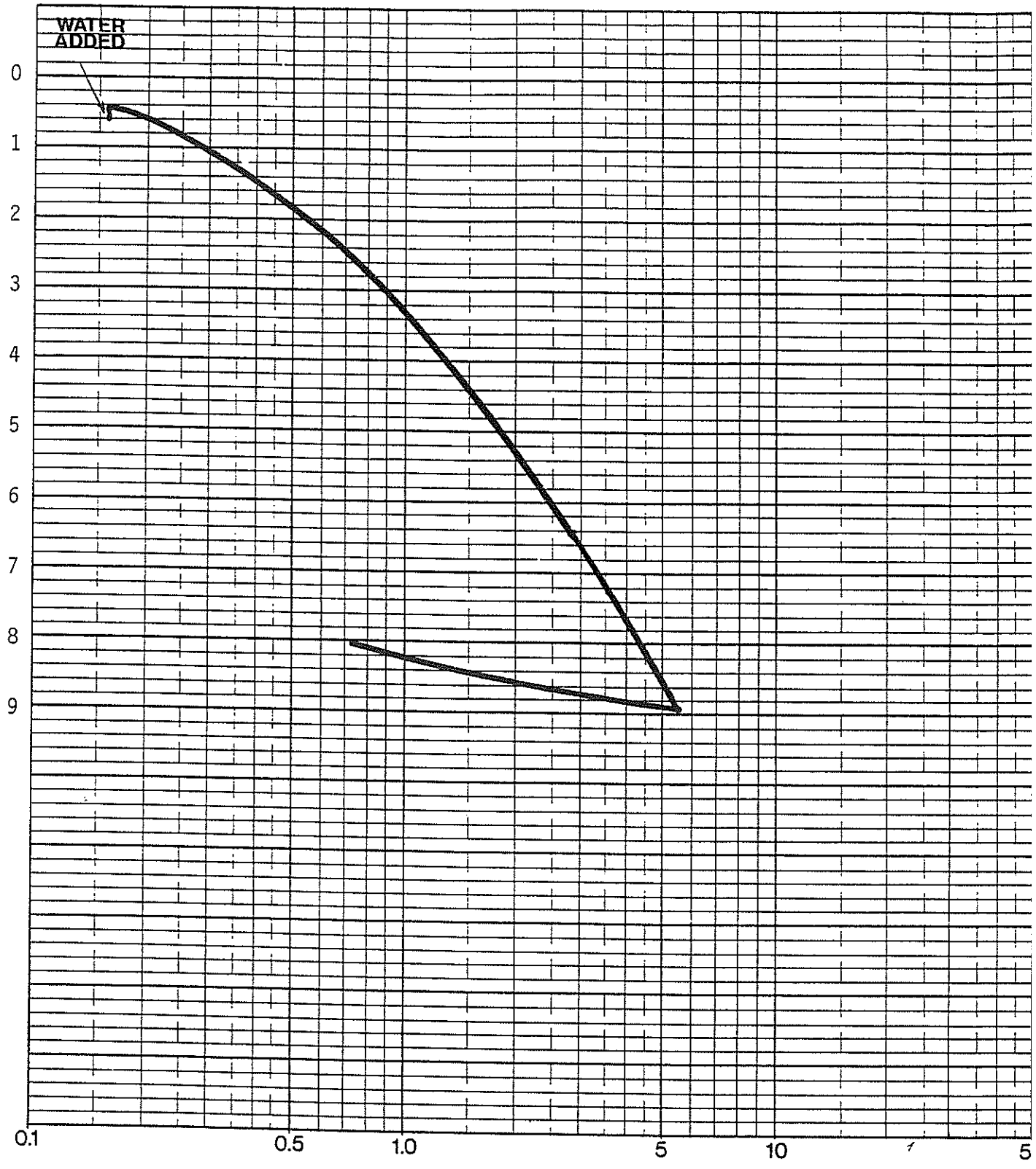
LOAD kips/sq.ft.

B1 @ 16'

SOUTHERN CALIFORNIA
SOIL & TESTING LAB, INC.
6280 RIVERDALE STREET
SAN DIEGO, CALIFORNIA 92120

MISSION BERMUDA TRIANGLE EXHIBIT

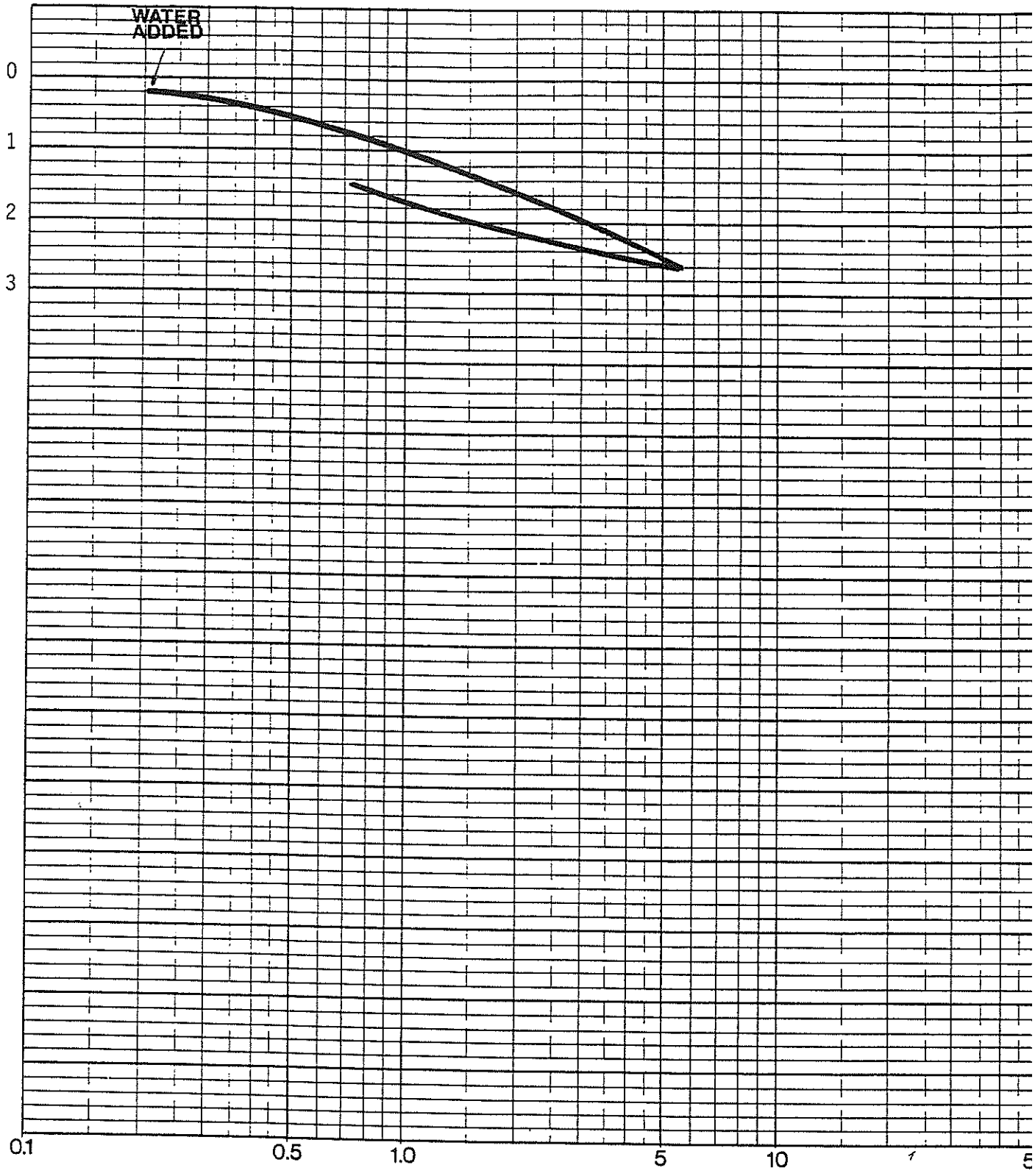
BY DBA	DATE 05-11-93
JOB NO. 9311068	Plate No. 24



SOUTHERN CALIFORNIA SOIL & TESTING LAB, INC.
6280 RIVERDALE STREET
SAN DIEGO, CALIFORNIA 92120

MISSION BERMUDA TRIANGLE EXHIBIT

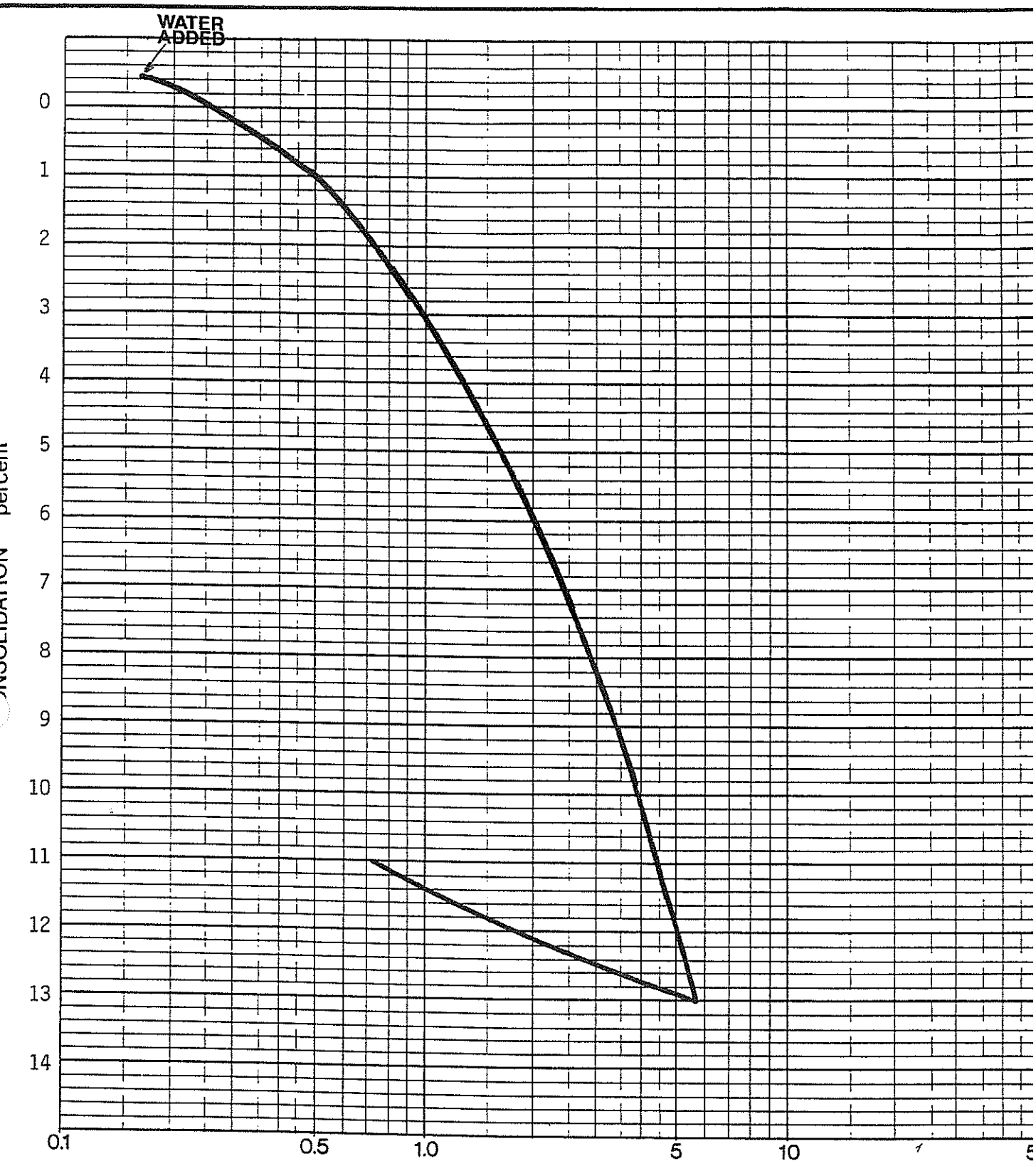
BY	DBA	DATE	05-11-93
JOB NO.	9311068		Plate No. 25



SOUTHERN CALIFORNIA
SOIL & TESTING LAB, INC.
6260 RIVERDALE STREET
SAN DIEGO, CALIFORNIA 92120

MISSION BERMUDA TRIANGLE EXHIBIT

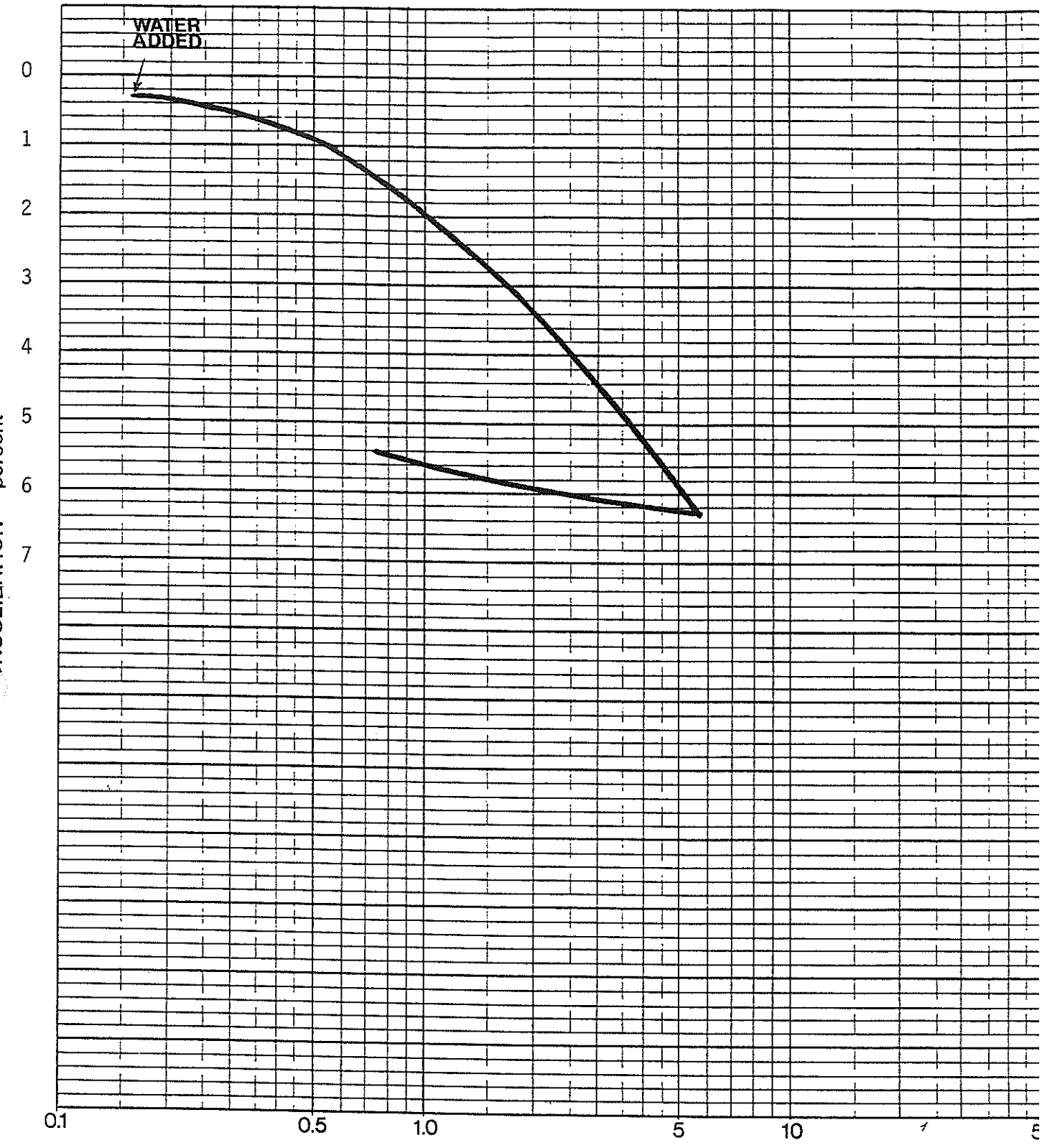
BY	DBA	DATE	05-11-93
JOB NO.	9311068		Plate No. 26



SOUTHERN CALIFORNIA
SOIL & TESTING LAB, INC.
6280 RIVERDALE STREET
SAN DIEGO, CALIFORNIA 92120

MISSION BERMUDA TRIANGLE EXHIBIT

BY	DBA	DATE	05-11-93
JOB NO.	9311068		Plate No. 27



SOUTHERN CALIFORNIA SOIL & TESTING LAB, INC.
6260 RIVERDALE STREET
SAN DIEGO, CALIFORNIA 92120

MISSION BERMUDA TRIANGLE EXHIBIT

BY DBA	DATE 05-11-93
JOB NO. 9311068	Plate No. 28

Appendix C

Liquefaction Analyses

Christian Wheeler Engineering
3980 Home Avenue
San Diego, California 92105

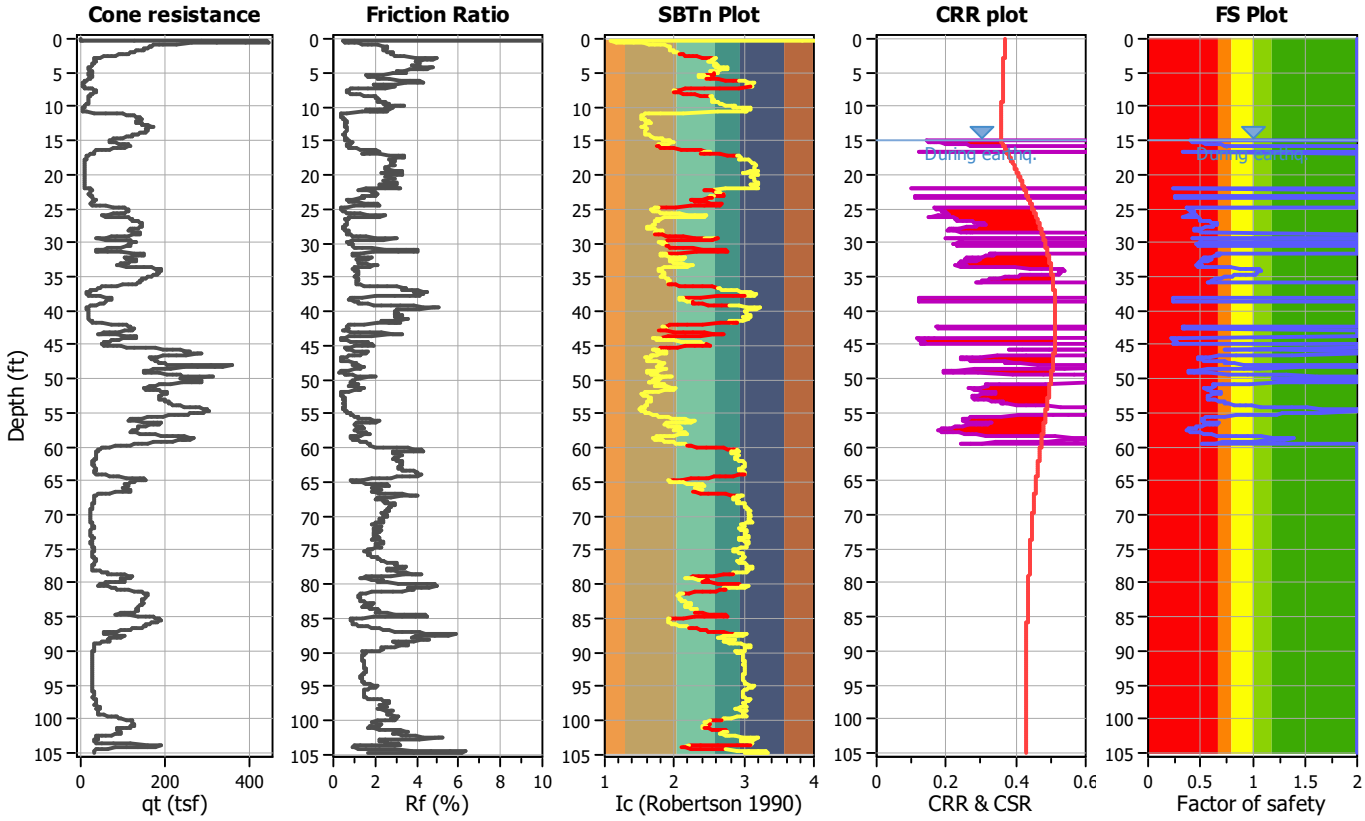
LIQUEFACTION ANALYSIS REPORT

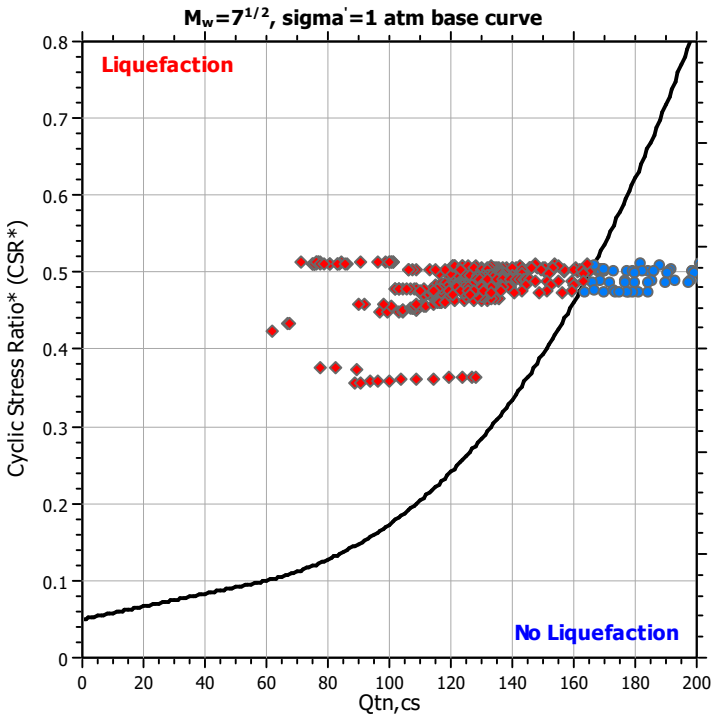
Project title : 2021 Project **Location : SeaWorld, San Diego**

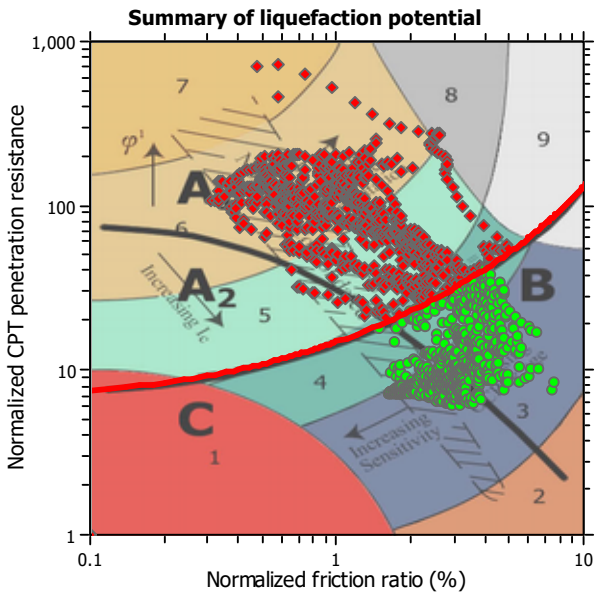
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	15.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	15.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.70	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

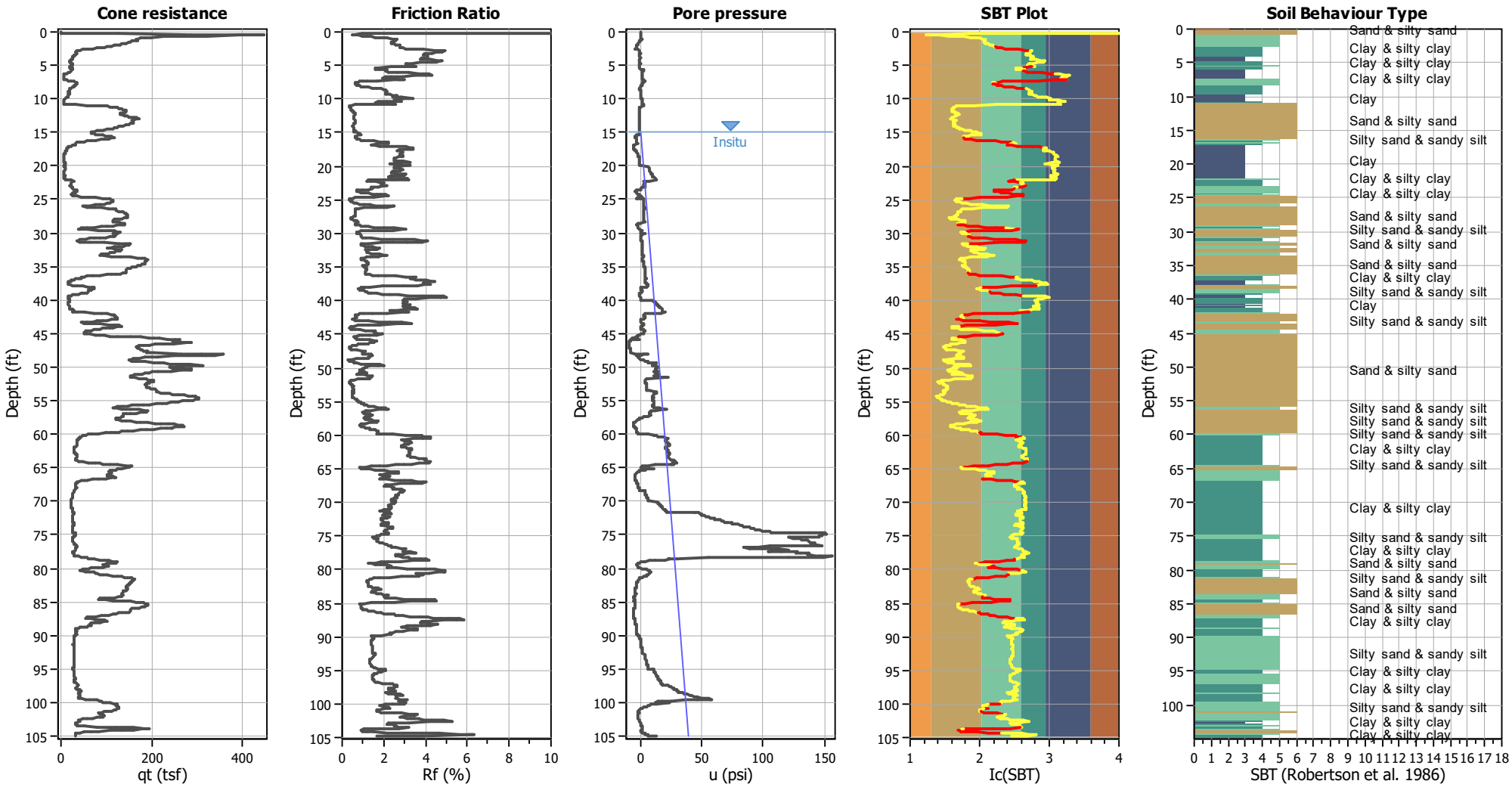






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



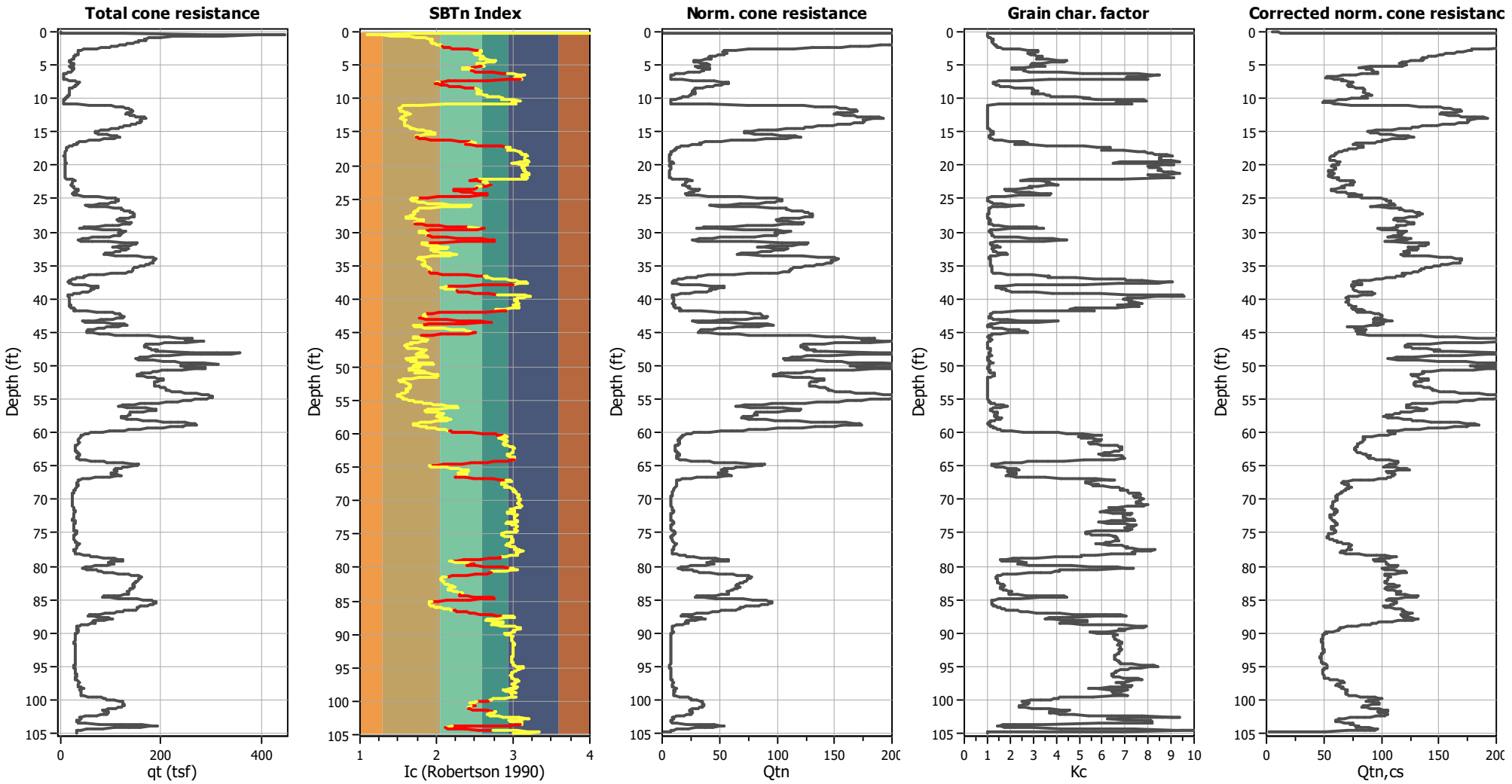
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

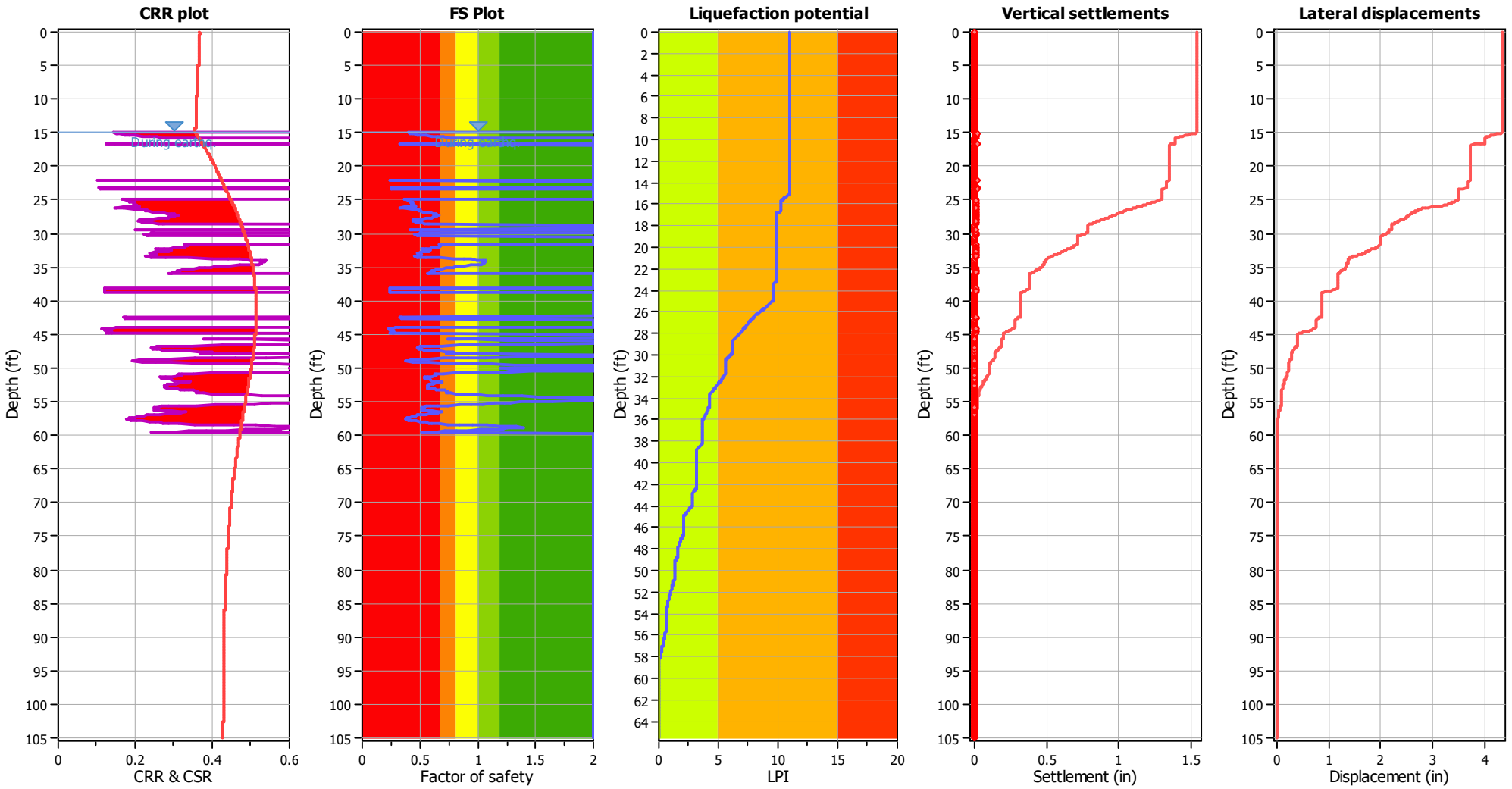
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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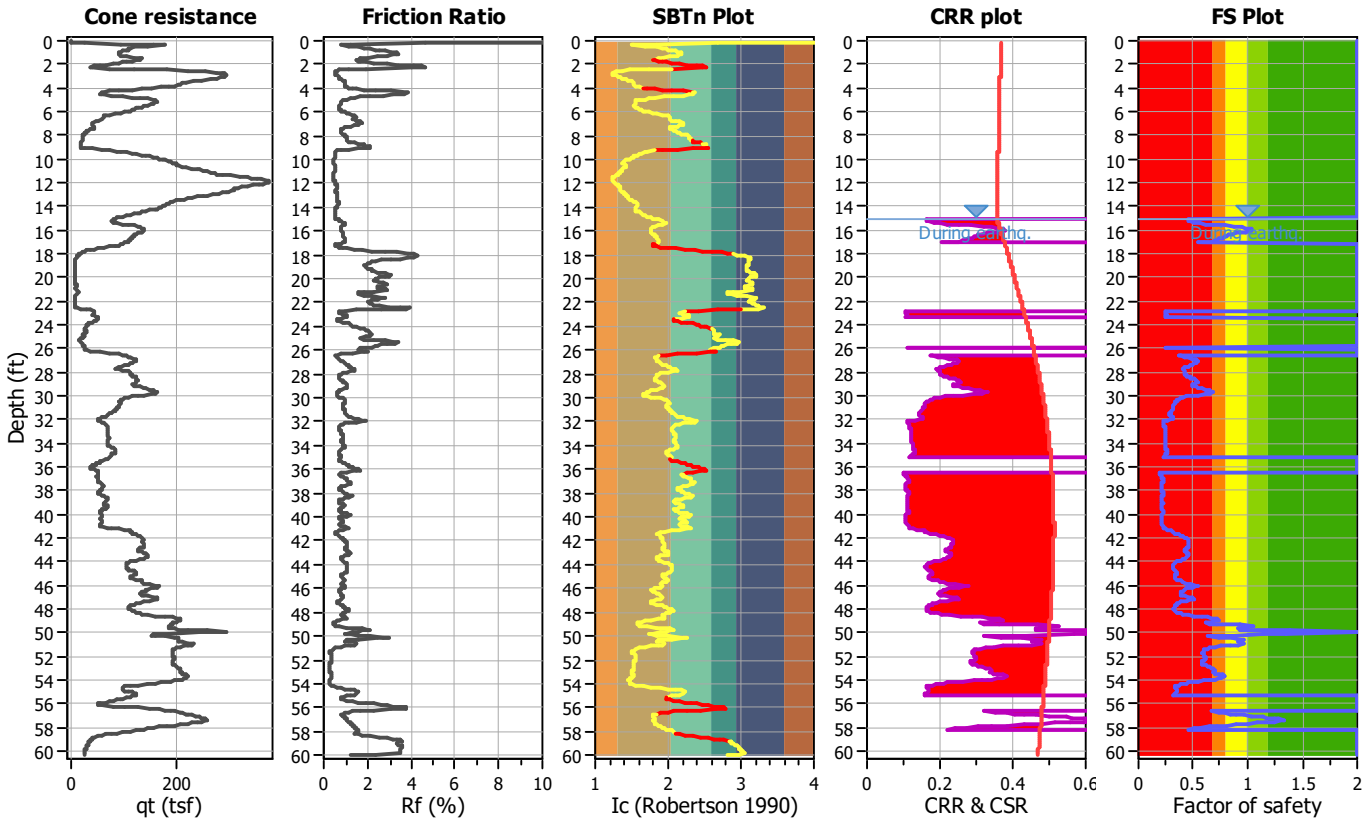
LIQUEFACTION ANALYSIS REPORT

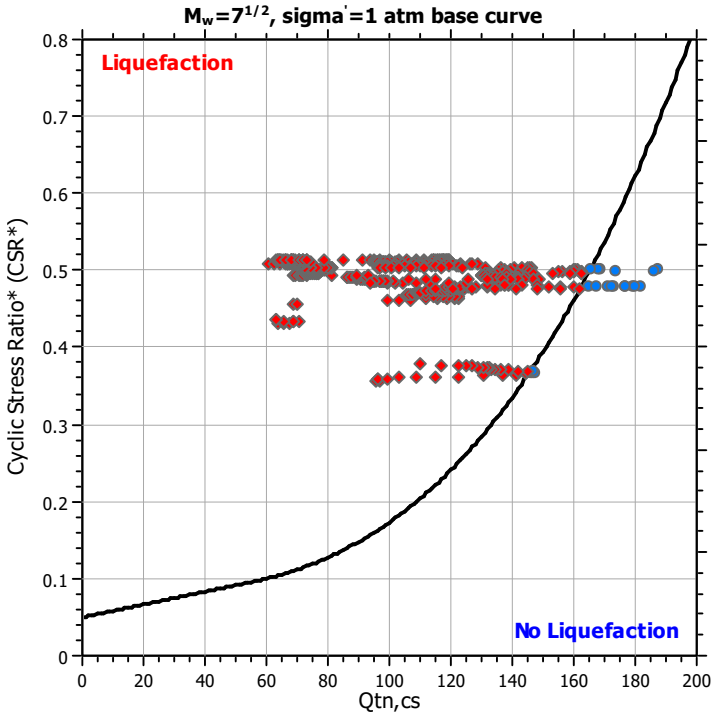
Project title : 2021 Project **Location : SeaWorld, San Diego**

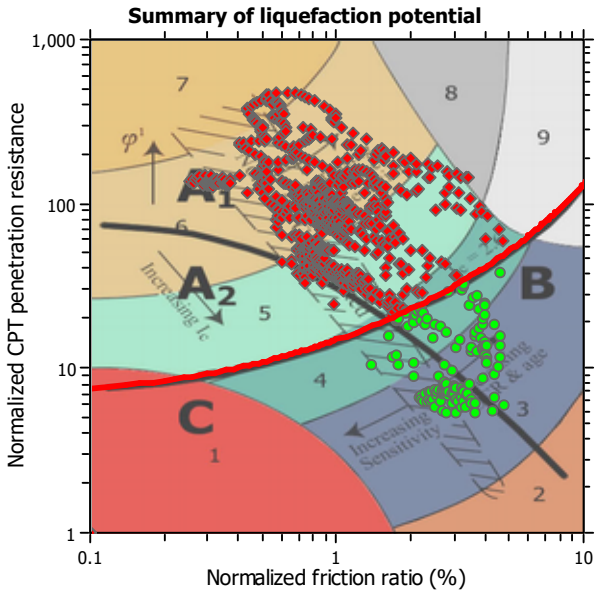
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	15.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	15.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.70	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

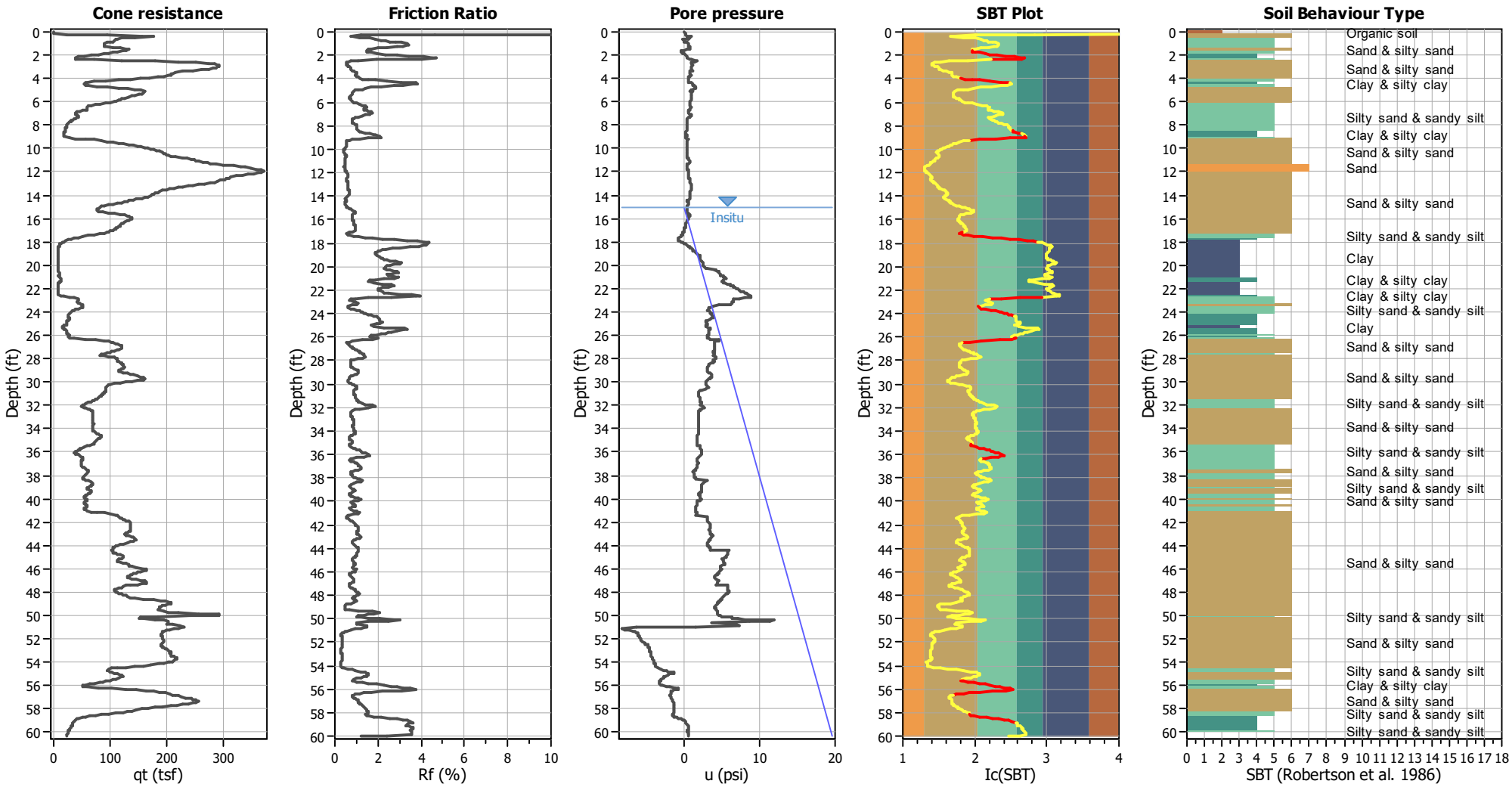






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



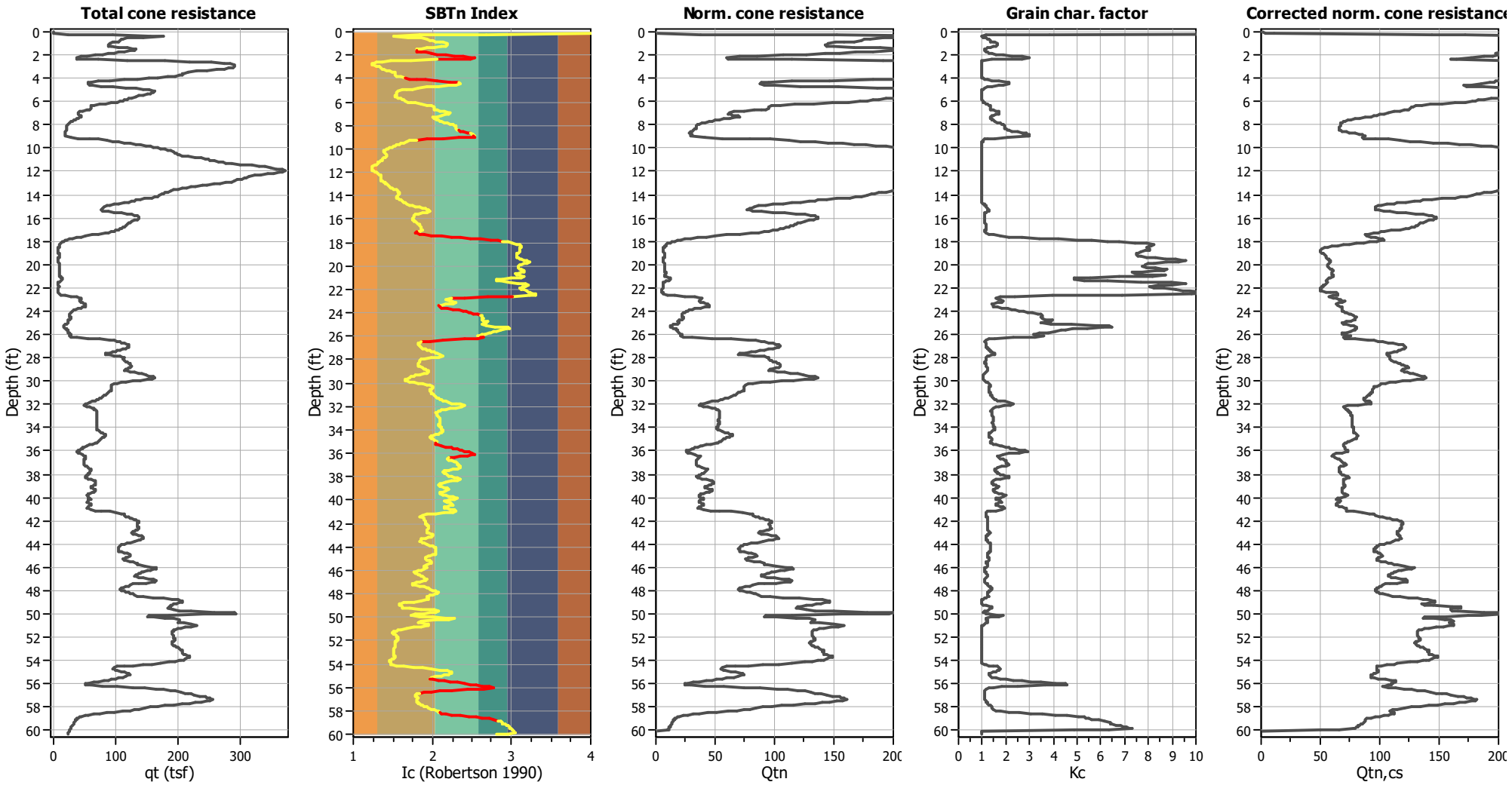
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

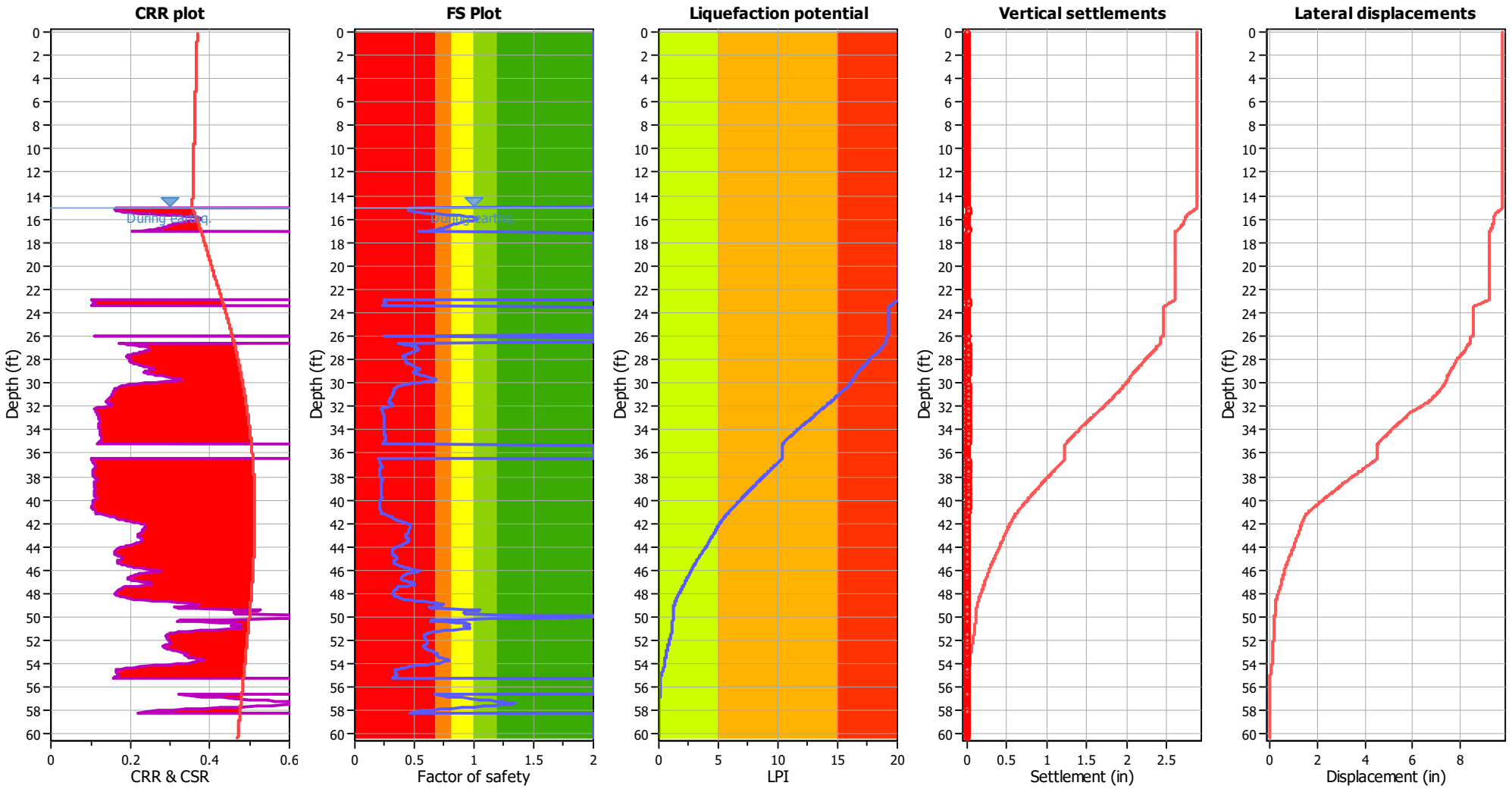
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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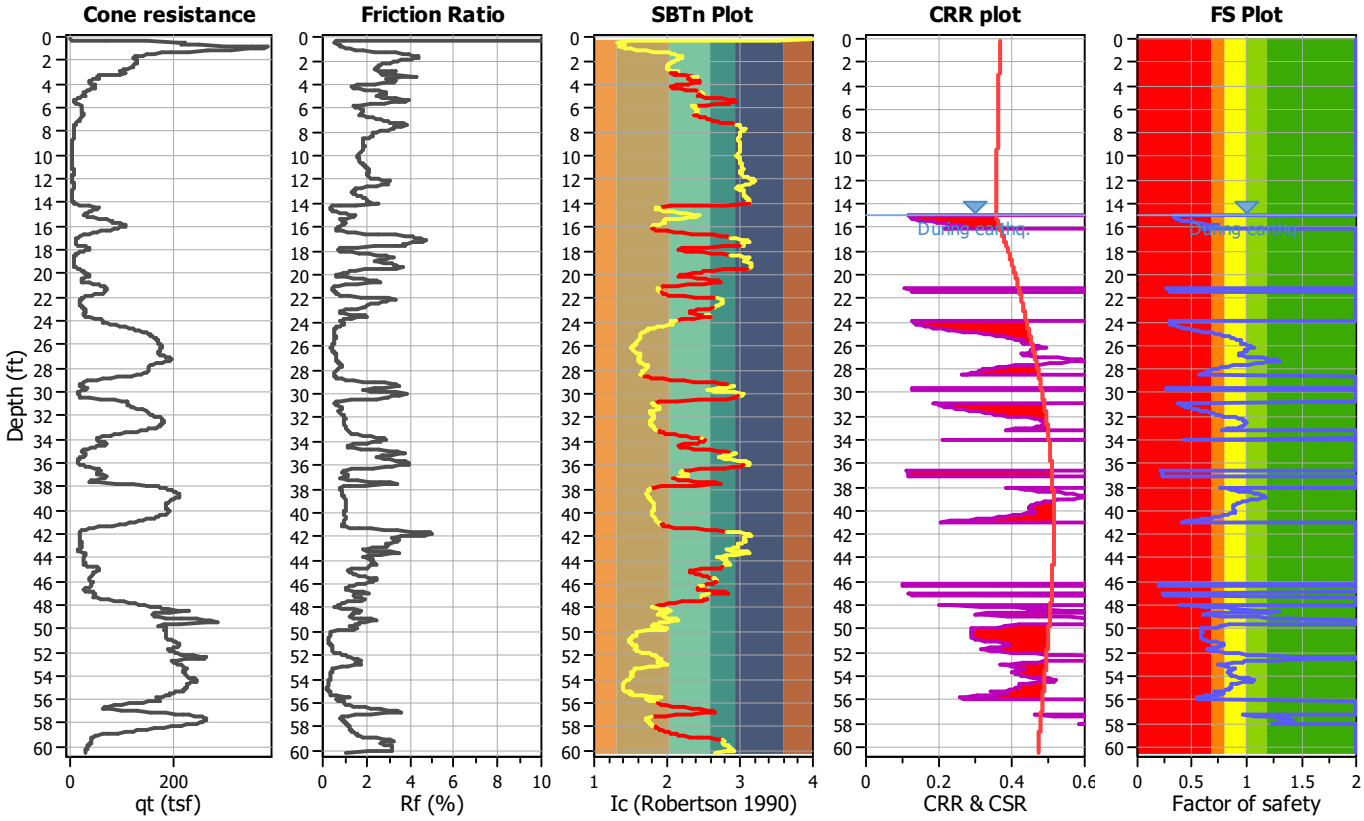
LIQUEFACTION ANALYSIS REPORT

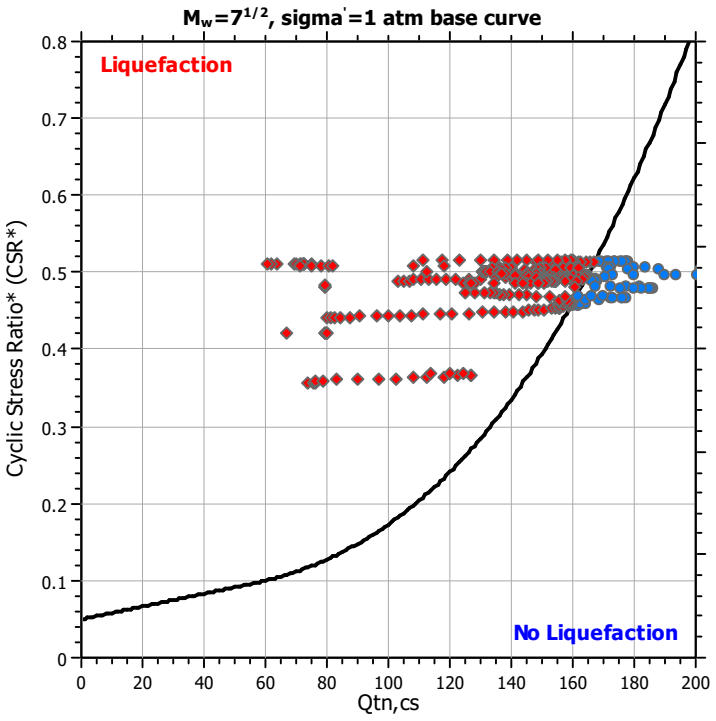
Project title : 2021 Project **Location : SeaWorld, San Diego**

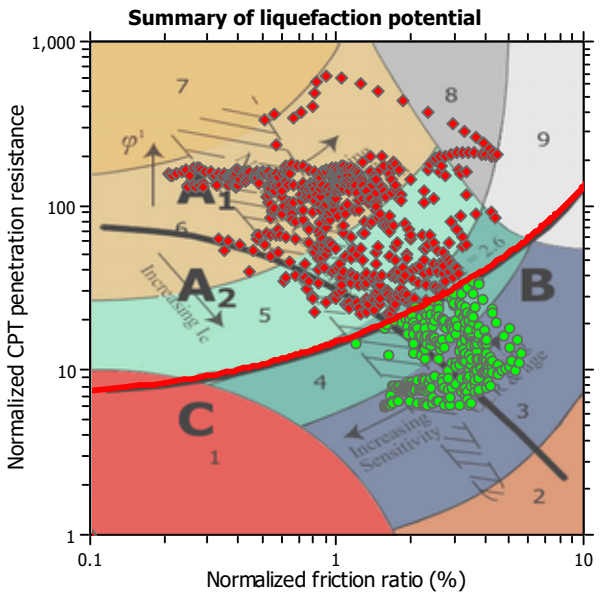
CPT file : CPT-3A

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	15.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	15.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.70	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

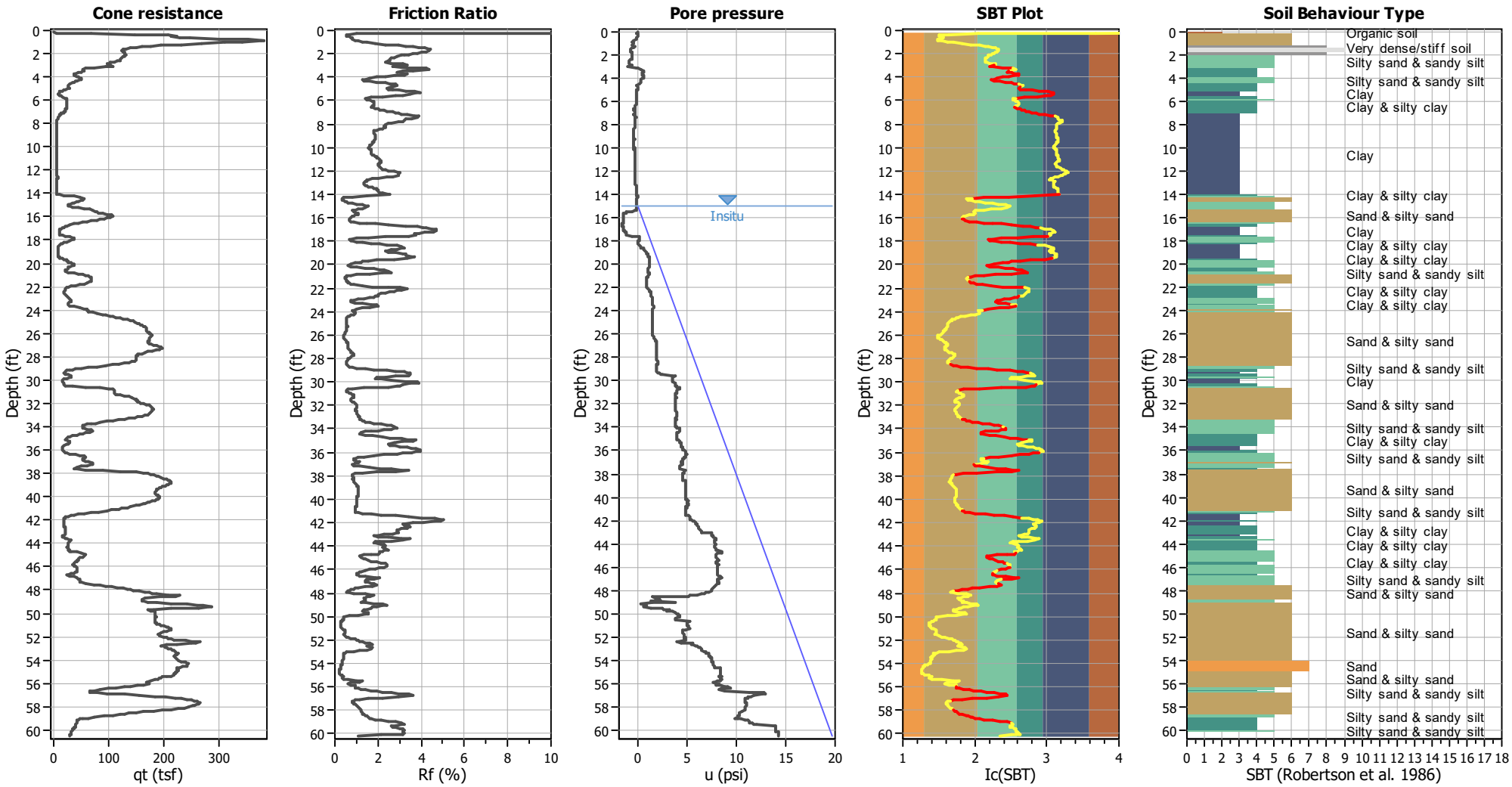






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



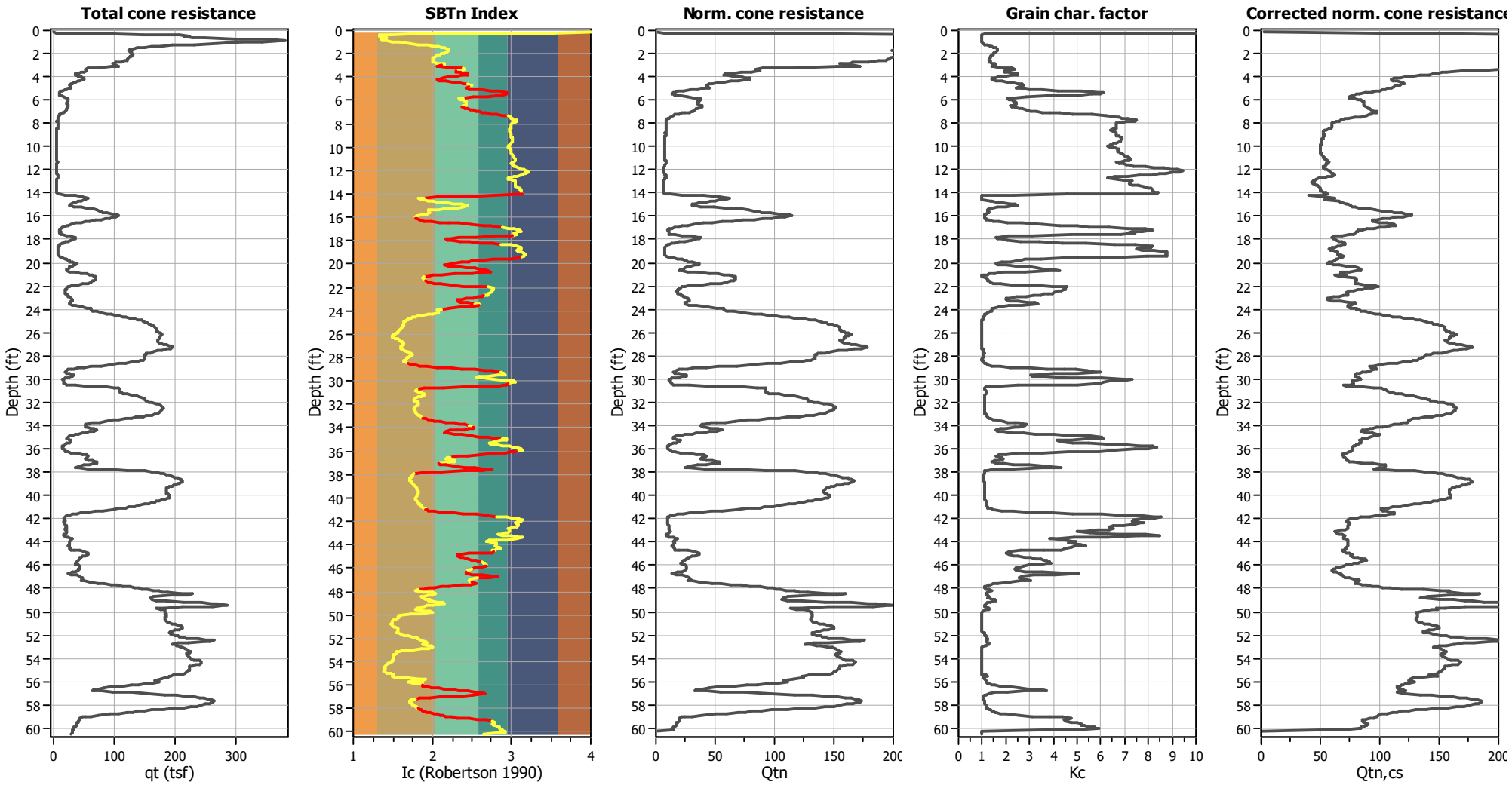
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

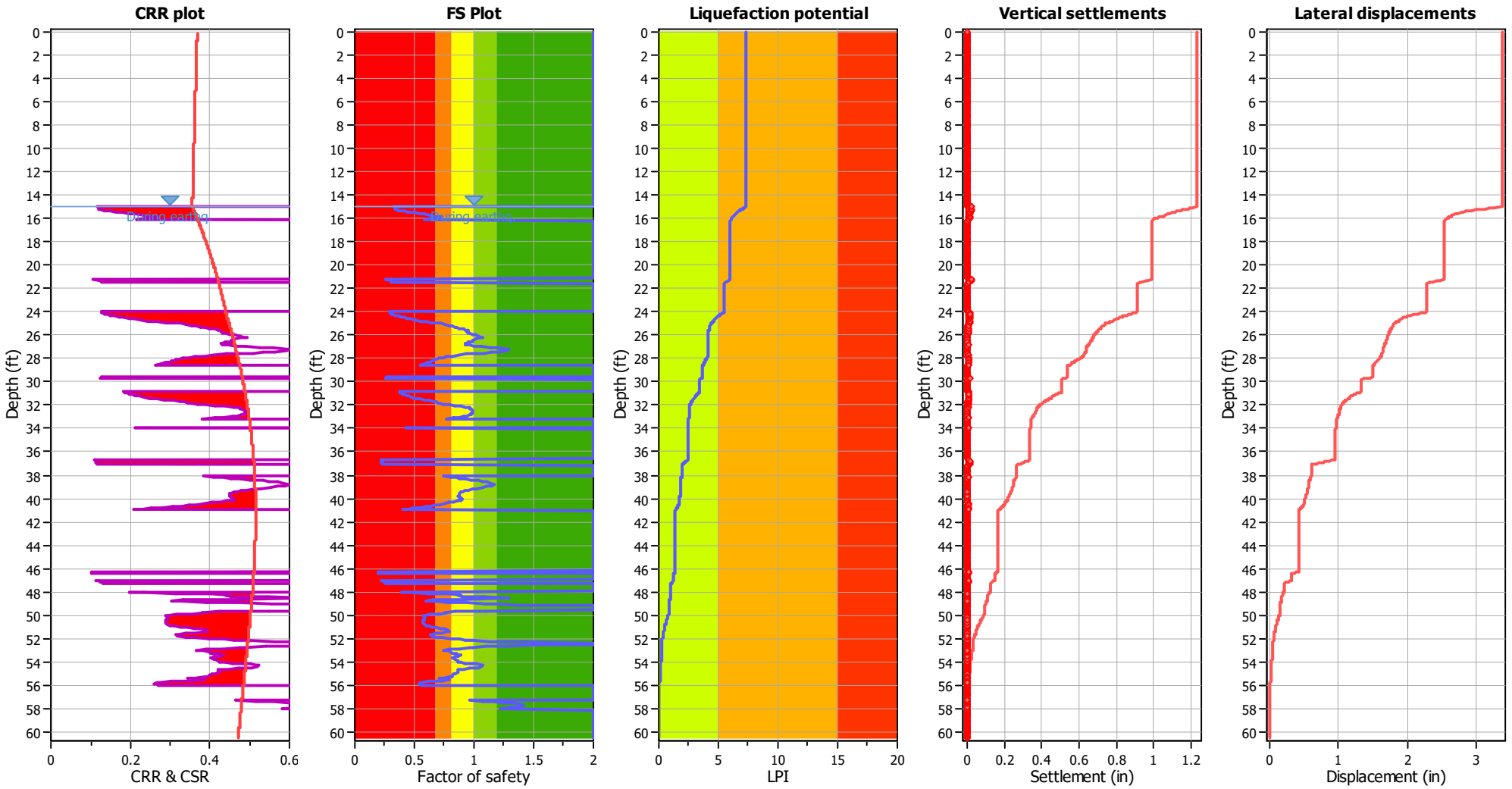
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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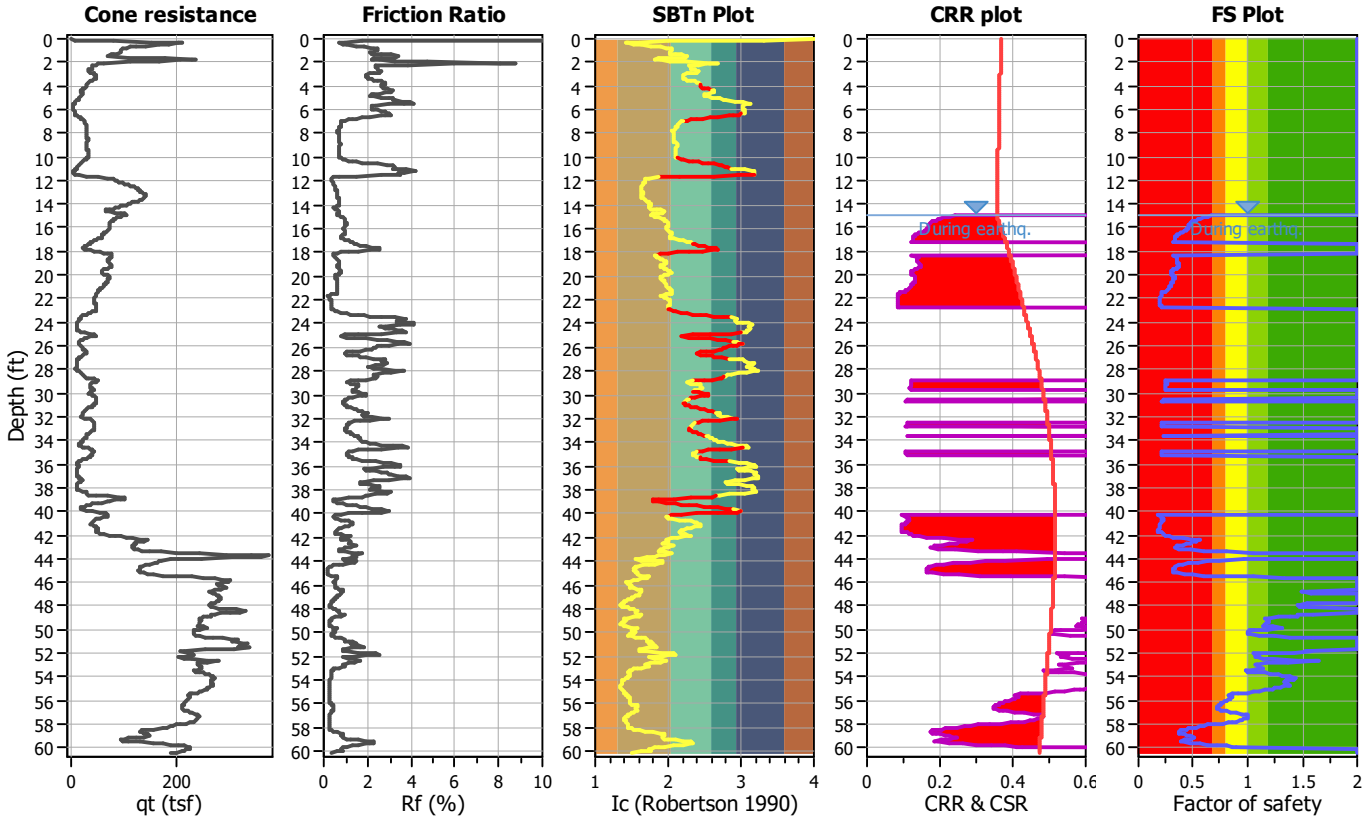
LIQUEFACTION ANALYSIS REPORT

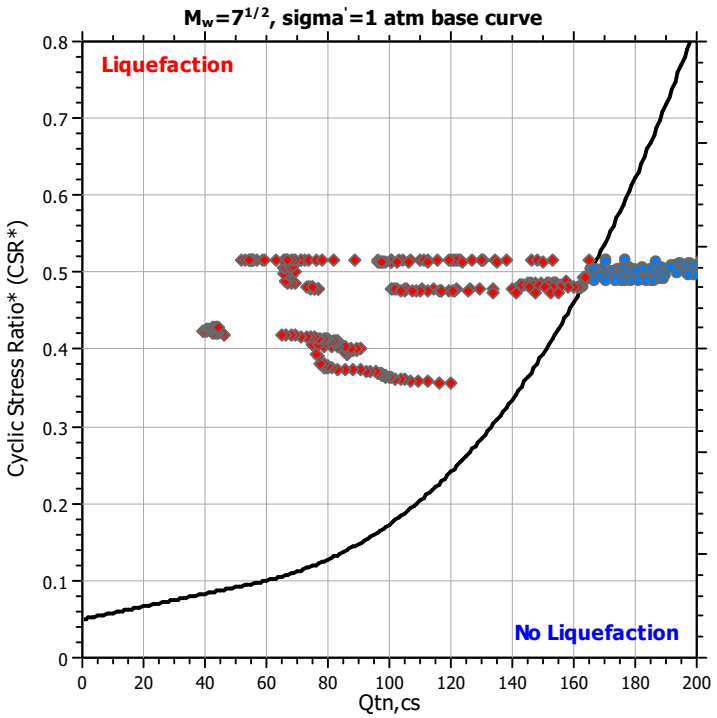
Project title : 2021 Project **Location : SeaWorld, San Diego**

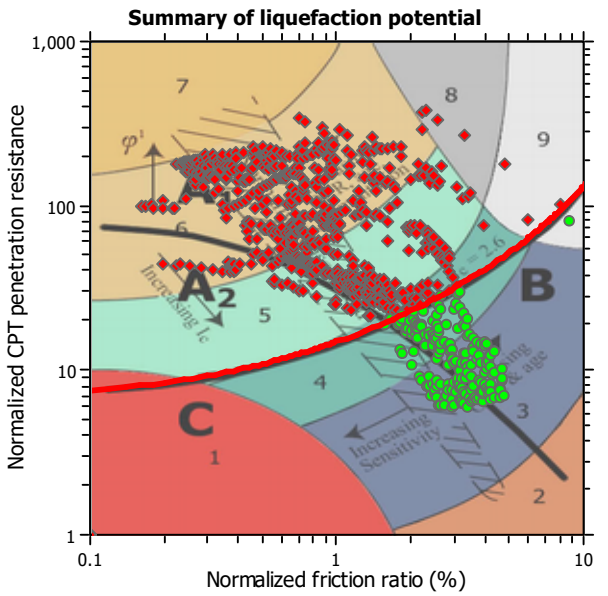
CPT file : CPT-4

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	15.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	15.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.70	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

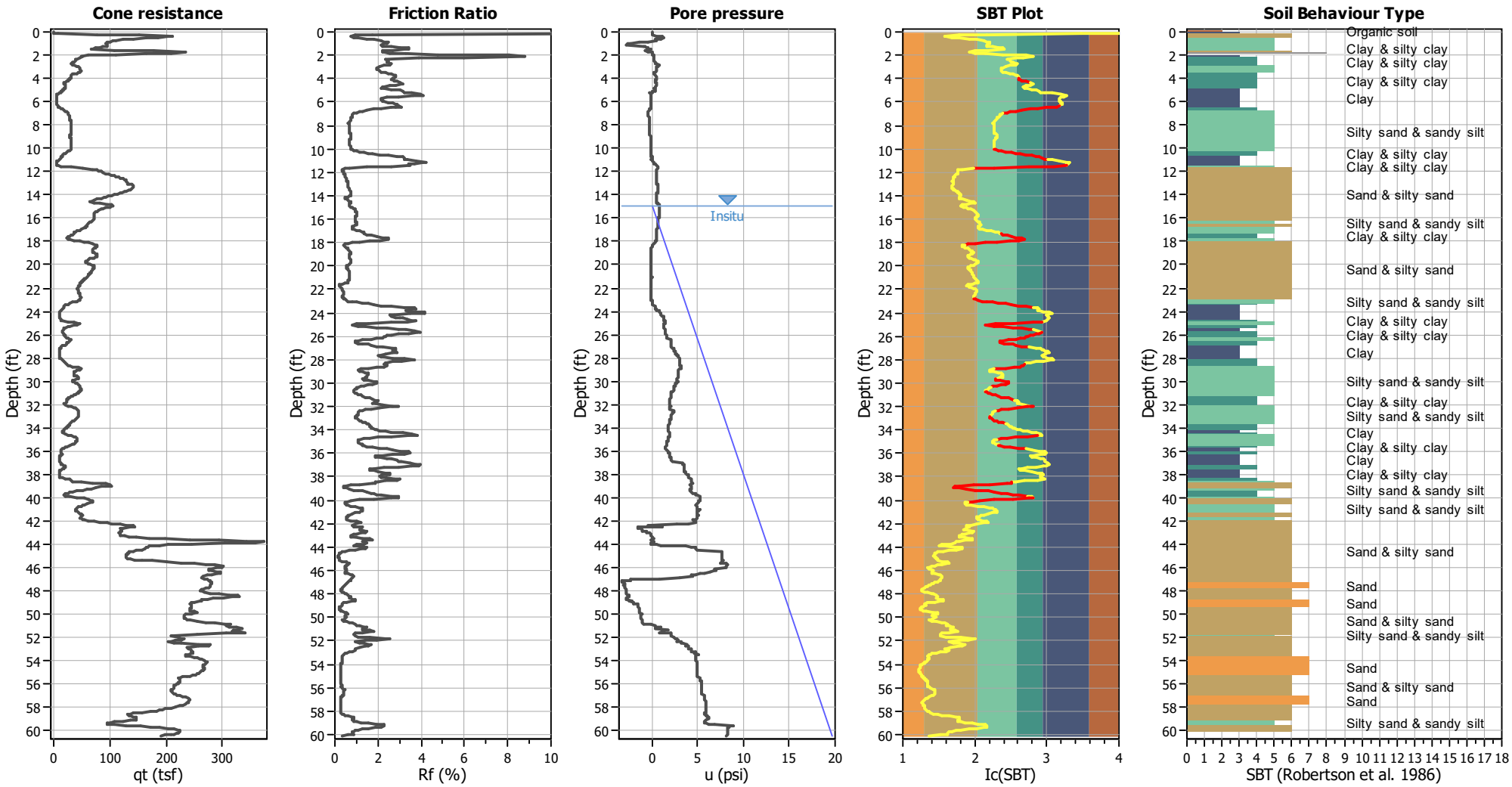






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



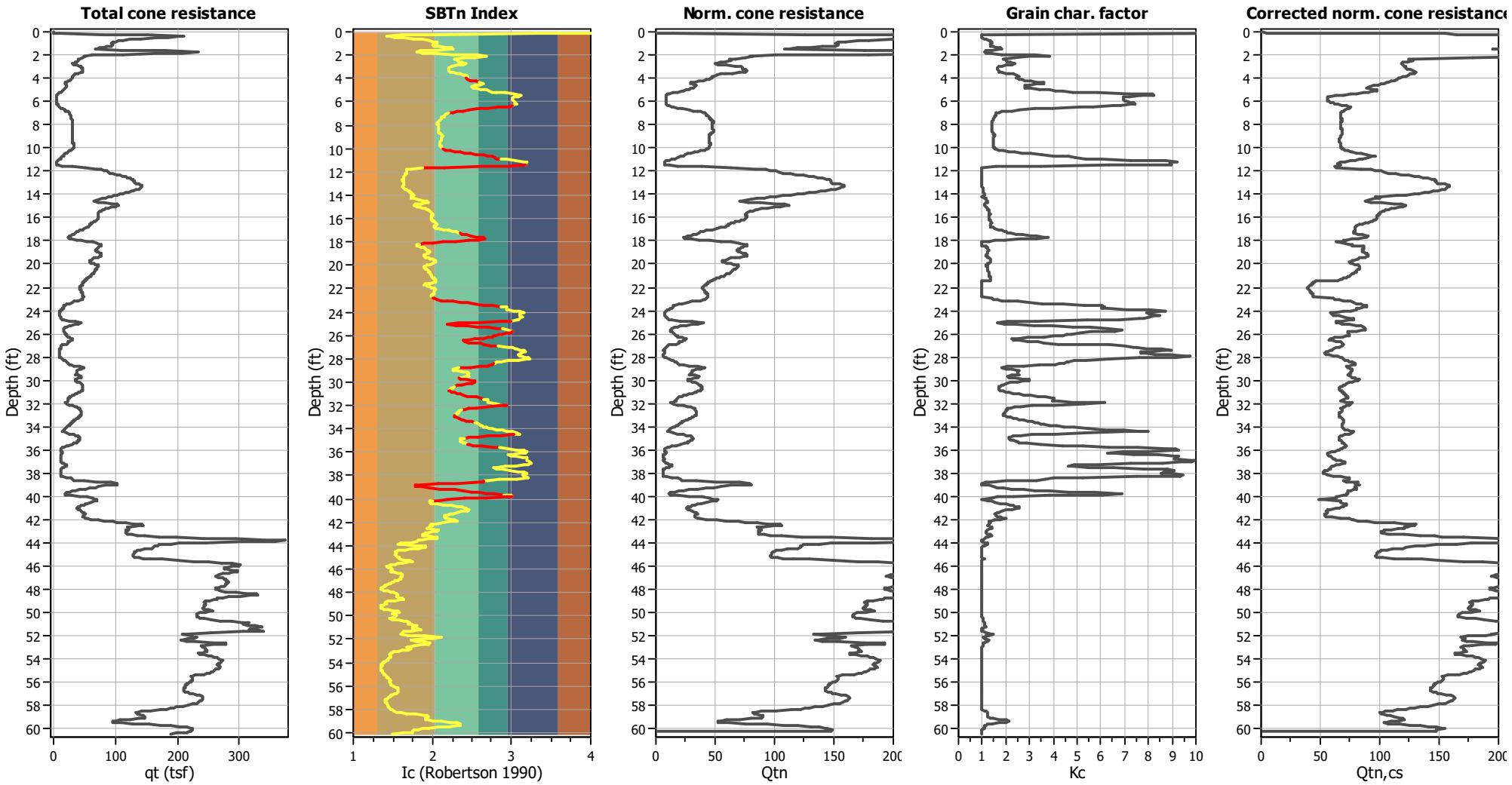
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

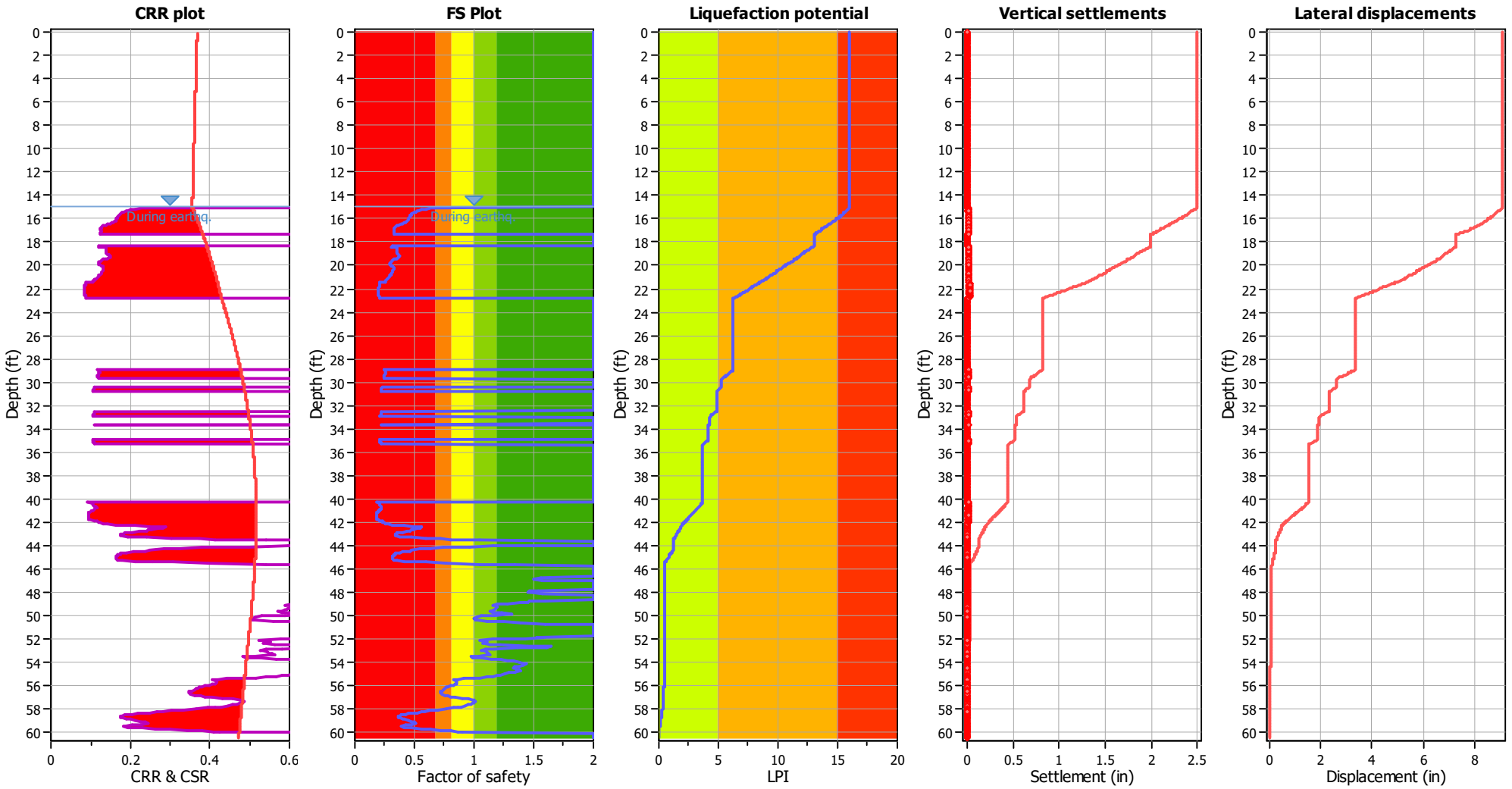
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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San Diego, California 92105

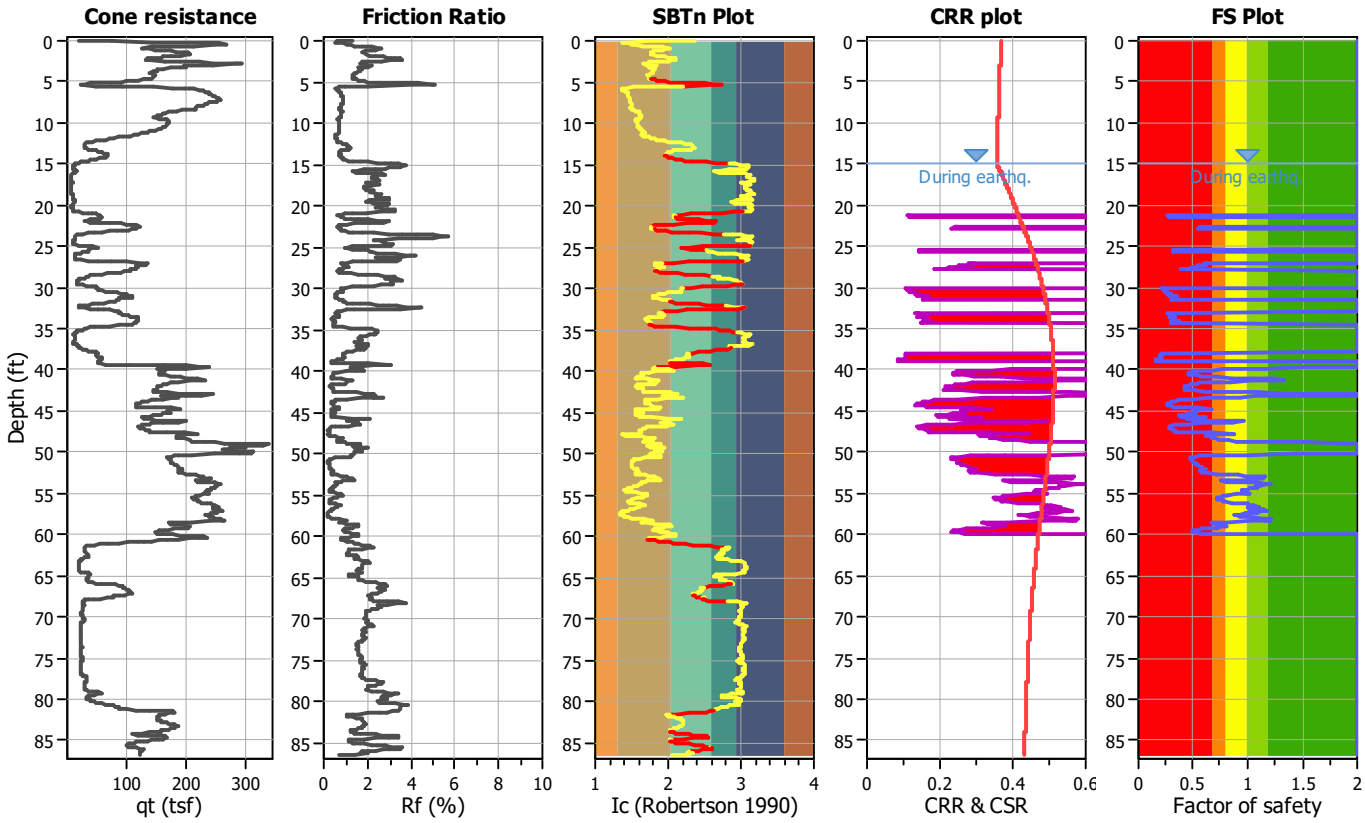
LIQUEFACTION ANALYSIS REPORT

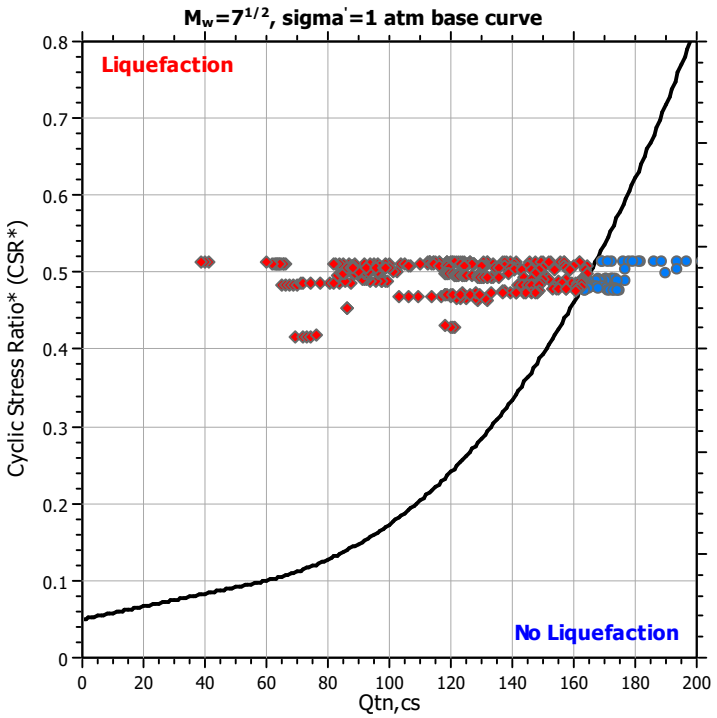
Project title : 2021 Project **Location : SeaWorld, San Diego**

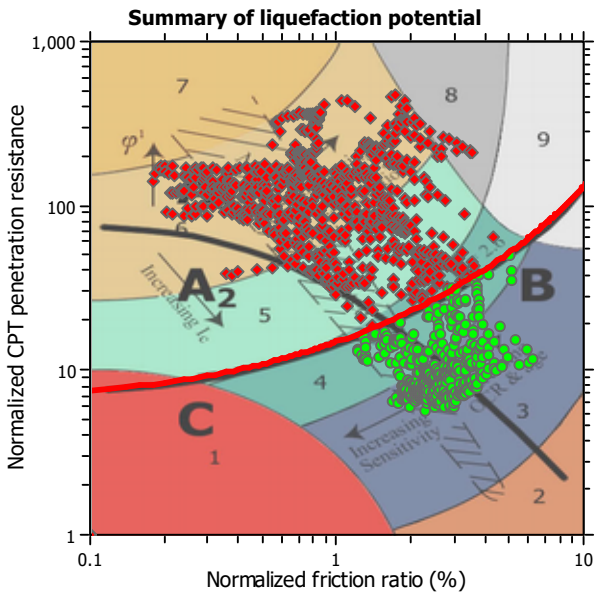
CPT file : CPT-5

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	15.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	15.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.70	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

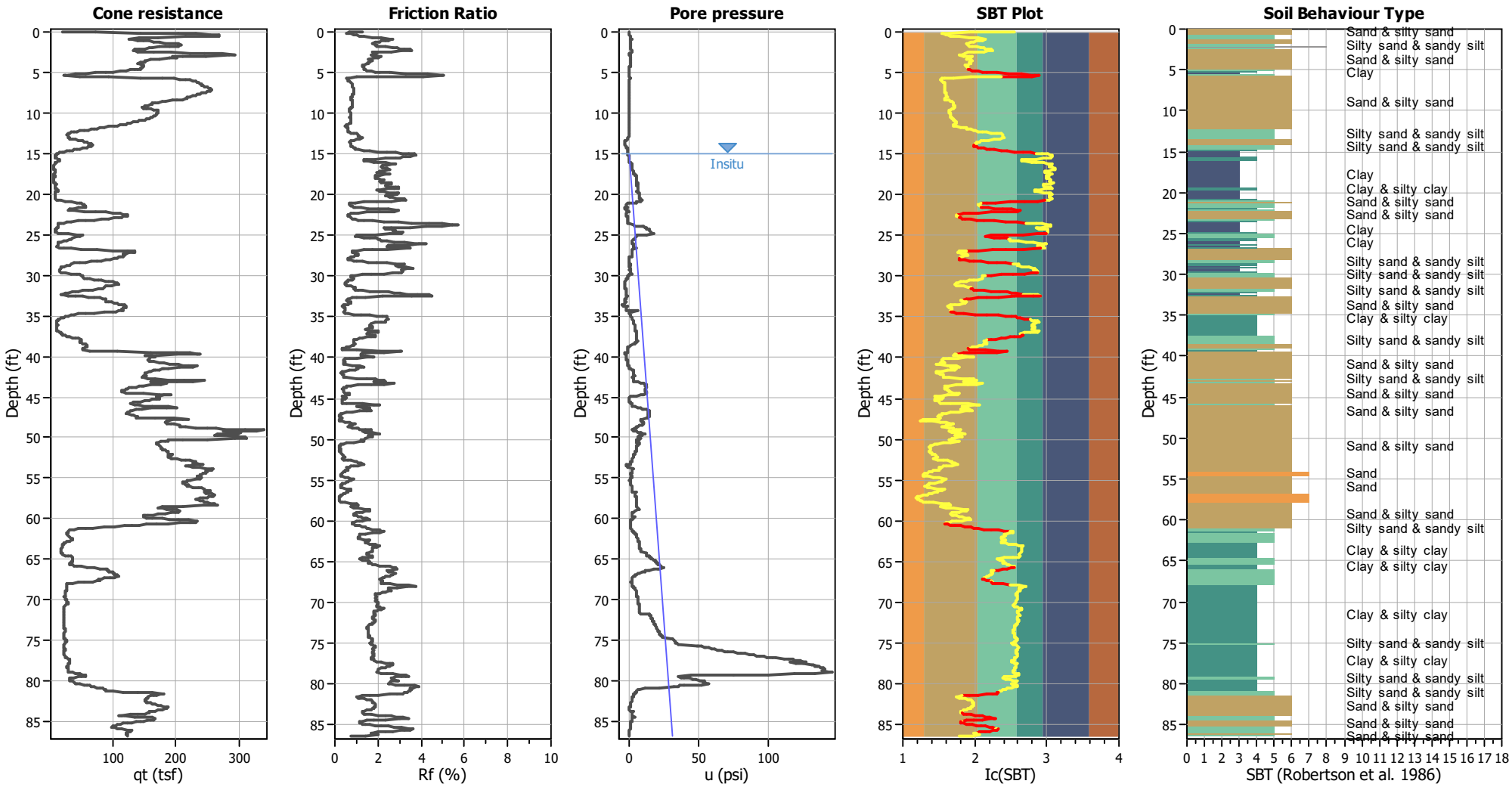






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



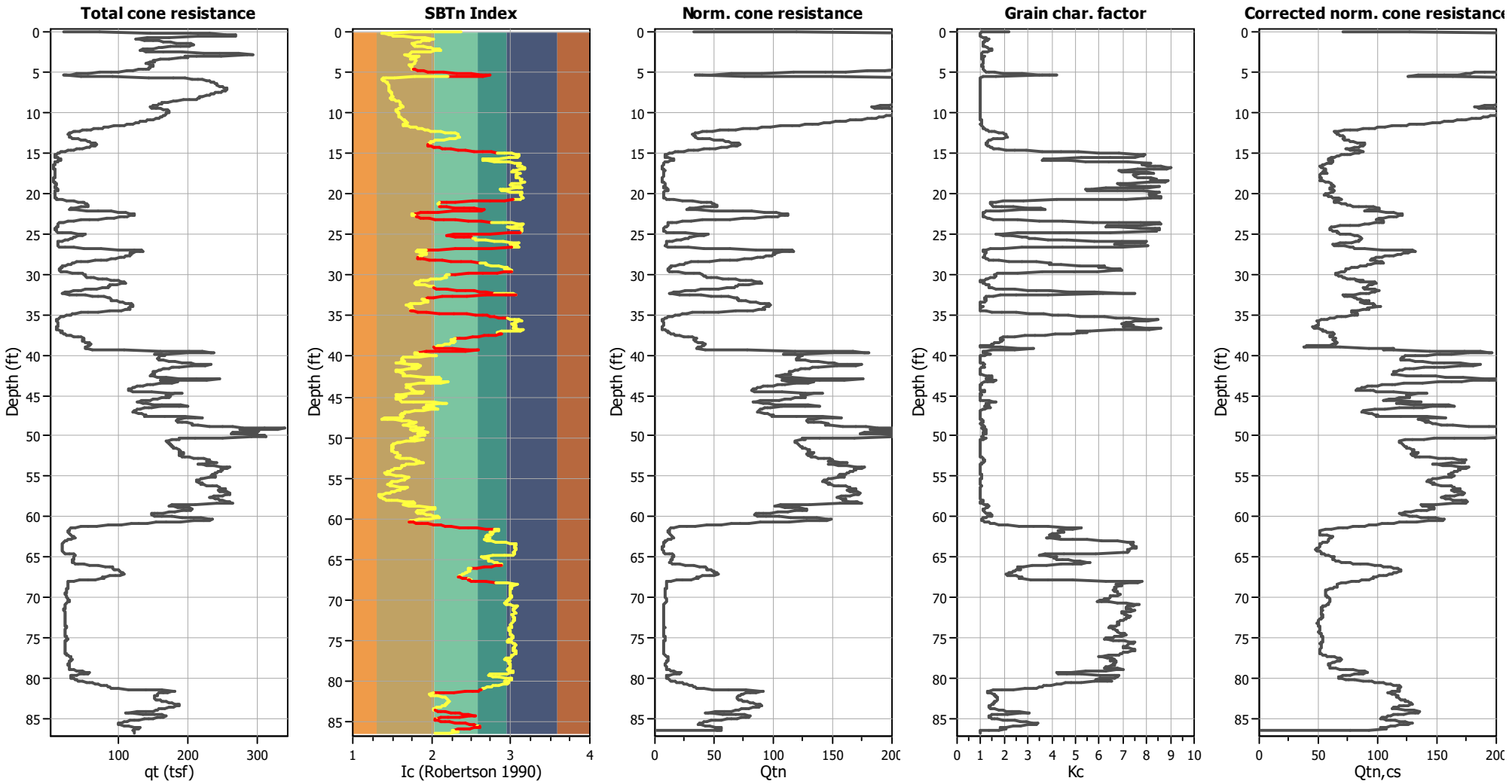
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

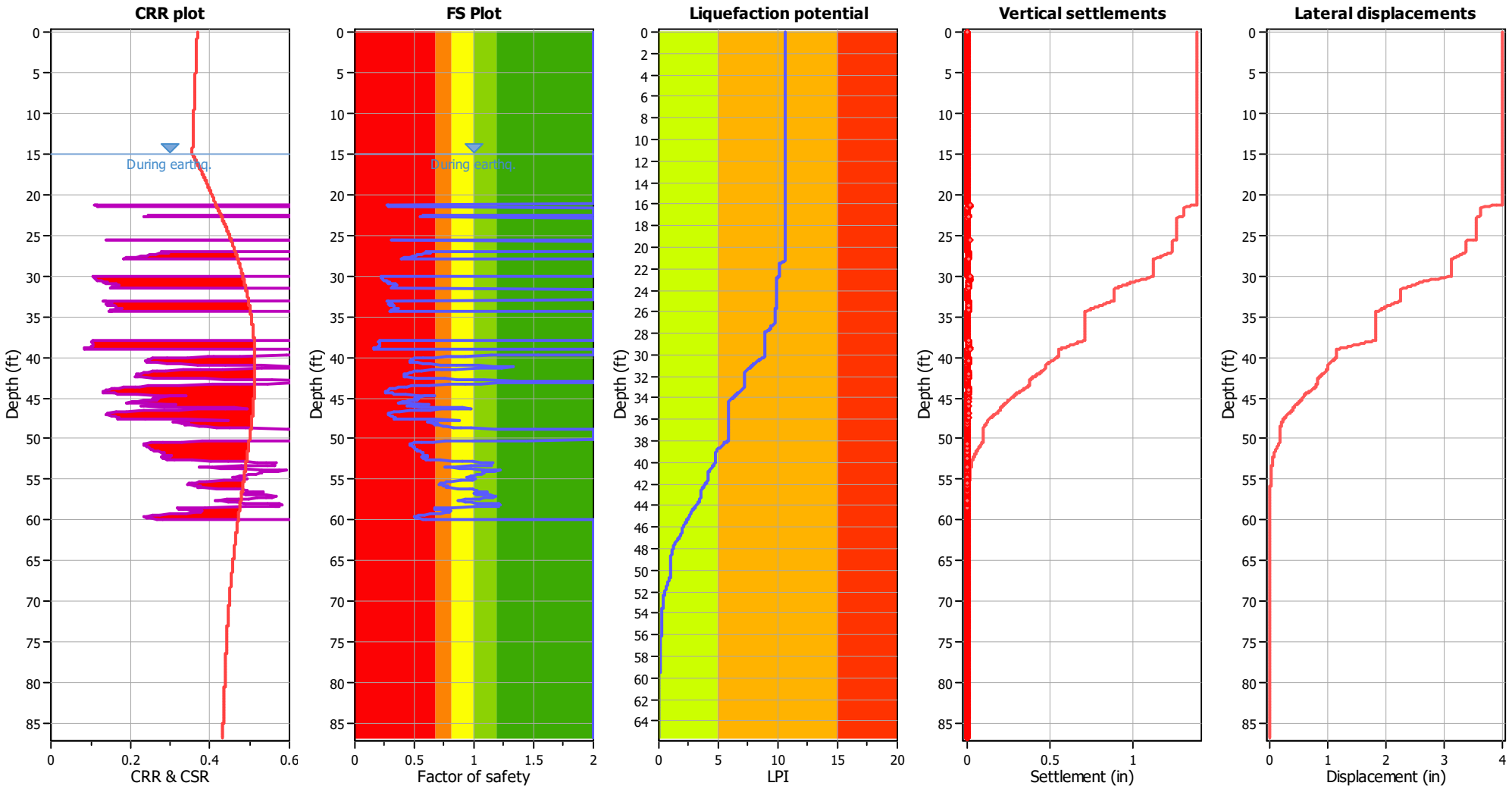
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	15.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	15.00 ft	Fill height:	N/A	Limit depth:	60.00 ft

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Appendix D

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SECTION 010300

SUMMARY OF PROJECT

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes:
   1. Contract Information
   2. Project Description.
   3. Regulatory Requirements.
   4. Access to the Site and Use of the Premises.
   5. Pre-construction meeting requirements.
   6. Security Procedures.
   7. Coordination Requirements.
   8. Order of Precedent in Drawings.
   9. Productivity Reporting (Artificial Rockwork.)
   10. Dust free environment.

B. Related Requirements:
   1. General Contract Conditions.
   2. Owner / Contractor Agreement.

1.02 CONTRACT

A. Contractor shall perform work as described in Owner / Contractor Agreement.

B. The Owner is:
   1. Sea World LLC d/b/a SeaWorld San Diego, a Delaware limited liability company, with offices at 500 Sea World Drive, San Diego, CA 92109 (“SEA”).

C. Parent Company: SeaWorld Parks & Entertainment, Inc., a Delaware corporation, with offices at 9205 South Park Center Loop, Suite 400, Orlando, FL 32819 (“SEA”).

D. Builder’s Risk Insurance: The Owner will purchase Builder’s Risk Insurance for all work performed by this contract and all work provided by other contractors on this project site.

1.03 PROJECT DESCRIPTION

A. Work under this contract shall include items shown in Contract Documents labeled 2021 Attraction, dated March 04, 2020.

B. Short Project Description:
   1. SeaWorld San Diego is adding a new attraction to the Wild Arctic area of the park. The attraction is an Intamin straddle coaster with three launches, which will be built adjacent to and within the Wild Artic simulator building. All four existing simulators will be decommissioned and removed, and approximately half of the building will be repurposed for the ride station, queue and non-rider area. The loading deck will be modified to allow flush loading to occur with a new exit platform and exit bridge over the low point of the ride. Ride electrical will be located within the building, below the ride and within a new ride electrical building located near launches 2 and 3. The remainder of the existing attraction building will be used for storage and show changing rooms. The current Retail area will remain unchanged as part of this project. Site preparation including construction access, construction fencing and grubbing related to the temporary access.
   2. Removal and Demolition
      a. Demolition of the structures and site improvements as designated on the drawings including relocation of Storage Yard, Nursery and Waste Area. Extent of work includes new fencing; Existing interior construction and theming to be removed.

b. Items and equipment identified as to be removed and returned to the Owner shall be undamaged and temporarily stored in protective containers. Contractor shall catalog such items noting their condition upon the disassembly and turn the list to the Owner's Project Manager at the completion of the work.

3. Dewatering
   a. Contractor shall obtain dewatering permit for dewatering. Prepare plan for dewatering and processing the permit and review with the Owner's Project Manager during the startup process.
4. Sitework
   a. Landscaping
      1) All plant material, including trees, palms, shrubs, vines and turf to be furnished by Owner and installed by Contractor.
   b. New pavement will meet ADA requirements for travel to all elements within the project limit line.
   c. Service Vehicle and Emergency Vehicle access road
   d. Ride restrictive fencing and Security Fencing
5. Queue and Station Building (Building 10)
6. EER Building (Building 20)
7. Ride Lockers and Ride Photo/Video (within Building 10)
8. Ride Maintenance Area

C. The Ride - Installation
1. This Work will include erection of a steel "straddle" coaster, installation of associated electrical, control and pneumatic assemblies.
2. Ride Erection Procedures: Refer to Owner's instructions for Ride Erection.

D. Items purchased by Owner and installed by Contractor
1. The Ride
   a. Ride structure.
   b. Ride control units.
   c. Ride electrical and pneumatic components installed on the ride structure.
   d. Ride Vehicles
   e. Actuating Gates
   f. Rolling Evacuation Stair
   g. AED Device
2. Ride Photo Equipment
   a. Computer hardware
   b. Cameras and associated strobe / flash lights
   c. Monitors
   d. Sales Kiosks
3. Ride Lockers and Kiosks
   a. Lockers
   b. Locker Self Service Kiosk

E. Work done by Owner or under separate contract direct to Owner
1. Pro-Safe System
   a. Specialty locking system for the Ride Restricted Area is to be purchased by the Owner and installed by the Owner.
2. Data and Communications equipment.
3. Security equipment.
4. Fire Alarm System

F. Existing Items to be Removed and Reinstalled by the Contractor
1. As part of this Work, the Contractor shall remove, protect, store and reinstall the items listed below.
   a. As Noted on Drawings

G. Performance Specifications
   1. As part of this Work, the Contractor shall provide specialty design and engineering for the Work defined by Performance Specifications and listed below.
   2. Contractor shall perform the works following the criteria and diagrams in Documents relative to quantity and engineering procedures.
   3. List of Performance Specifications:
      a. 015000 Temporary Facilities and Services
      b. 024119 Selective Demolition
      c. 051200 Structural Steel Framing
      d. 054000 Cold-Formed Metal Framing
      e. 054500 Secondary Metal Support Assemblies
      f. 055000 Metal Fabrications
      g. 055100 Metal Stairs
      h. 055213 Metal Pipe and Tube Railings
      i. 061756 Wood trusses
      j. 076100 Sheet Metal Roofing
      k. 084313 Aluminum Framed Storefronts
      l. 101900 Exhibits and Graphics
      m. 130002 Artificial Rockwork
      n. 133100 Fabricated Engineered Structures
      o. 211313 Wet Pipe Sprinkler Systems
      p. 220549 Seismic Restraint for Plumbing Systems
      q. 230549 Seismic Restraint for HVAC
      r. 260549 Seismic Restraint for Electrical Systems

H. Pre-Installation Conferences
   1. As part of this Work, the Contractor shall organize and manage specific pre-installation conferences prior to the commencement of specific work for the sections referenced below at a minimum.
   2. Contractor to follow all specification sections for Pre-Installation Conference requirements additional to those listed below.
   3. List of Specifications requiring Pre-Installation Conferences:
      a. 033000 Cast-in-Place Concrete
      b. 051200 Structural Steel Framing
      c. 055213 Metal Pipe and Tube Railings
      d. 061756 Shop-Fabricated Wood Trusses
      e. 064300 Wood Railings
      f. 076200 Sheet Metal Flashing and Trim
      g. 087100 Door Hardware
      h. 131433 Actuating Gates
      i. 133419 Metal Building Systems
      j. 211316 Dry-Pipe Sprinkler Systems
      k. 260533 Raceway and Boxes for Electrical Systems
      l. 315000 Excavation Support and Protection

I. Contractor shall closely monitor its work and cooperate and coordinate with separate contractors concurrently furnishing materials and performing work on this project. The work of other contractors will not be an acceptable reason for extension of the schedule.

J. Project Schedule:
   1. Refer to Form of Proposal and Contract for project schedule.

K. Corrosive Environment Limits
   1. The following locations shall be considered within the limits of corrosive environments. Refer to specific specification sections for material requirements within the corrosive limit.

a. The entire project site shall be considered within the limits of corrosive environments.]

L. Utility Interconnections:
   1. Contractor shall coordinate all utility interconnections a minimum of 48 hours prior to commencing work, or as directed by the client.
   2. Contractor shall make all interconnections to existing utilities that will disrupt ongoing Park operations while Park is closed. Contractor shall account for any premium costs for overtime or off hour work within bid.
      a. Park closed hours shall be considered a minimum of one hour prior to opening and one hour after closing.
   3. For any utility disruption that shall extend beyond one day, contractor shall provide temporary services complying with Section 015000.

1.04 REGULATORY REQUIREMENTS

A. SAN DIEGO, CALIFORNIA
   1. Requirements of the City of San Diego Building Department.
   2. California Building Code, 2019.
   3. California Existing Building Code, 2019
   4. California Green Building Standards Code, CALGreen, 2019.
   5. California Energy Code, 2019.
   6. California Fire Code, 2019.
   7. California Mechanical Code, 2019.
   8. California Plumbing Code, 2019
   9. California Electrical Code, 2019.
   10. Federal and State Accessibility Regulations.
      a. Americans with Disabilities Act, 2010 ADA Standards for Accessibility Design.
      b. California Accessibility Code, CALDAG, 2019.
   11. Specific codes and regulations as referenced in various sections of the documents.

1.05 ACCESS TO THE SITE AND USE OF THE PREMISES

A. The space available to the Contractor for the performance of the Work, either exclusively or in conjunction with others performing other construction as part of the project, is shown on the drawings.
   1. Other areas are off limits to all construction personnel.

B. Signs: Contractor shall provide signs adequate to direct visitors.
   1. Contractor shall not install, or allow to be installed, signs other than specified directional signs identifying the principal entities involved in the project.

C. Access to site will be extremely limited; Contractor shall obtain approval from the Owner's Project Manager of proposed routes of access.

D. Access through the eastern parking gate will be the primary construction vehicle access to the construction site. During the Park Operation Hours the Contractor will need to coordinate with owner on construction traffic so as not to interfere with Guest parking or school groups. There will be gate access to the main park path. Access will be limited to:
   1. Between 10:00 PM and 8:30 AM - unrestricted access.
   2. Between 8:30 AM and 10:30 AM - no access, gates must remain closed.
   3. Between 10:30 AM and 10:00 PM - construction vehicle traffic will be restricted to 10 (ten) minutes per each hour. Contractor shall schedule the gate openings. Owner's Project Manager will assist Contractor with the related Park Operations procedures.

E. Parking for the Construction Crews:
   1. Owner will provide remote parking located not farther than one half miles from the site during the following dates:

a. All weekends.
b. Between and including the Saturday preceding Memorial Day and Labor Day.
c. Between and including the Saturday preceding and the Sunday following Thanksgiving.
d. Between and including the Saturday preceding Christmas and New Year's day.

2. Bus service to be provided by Contractor.

F. Work in Service Drive:
1. Unless indicated in drawings, at no time shall the Contractor completely close the Service Drive. A twelve feet (12'-0") wide driving lane shall be maintained for both Park vehicles and emergency vehicles.
2. When complete closure is required, the closure shall not be longer than 4 hours in duration and shall be scheduled with the Owner's Project Manager two weeks in advance.
3. Temporary Facilities shall be provided as specified in Section 015000.

G. The work will be performed in proximity to animal areas. Noise and vibration will be restricted during the animal night rest time, between hours 11:00 PM and 6:00 AM.
1. Noise reduction measures will be required during construction. These include:
a. Restricted noisy operation times.
b. Equipment and tool restrictions based on noise.

1.06 PRE-CONSTRUCTION MEETING

A. A pre-construction meeting will be held at a time and place designated by the Owner's Project Manager, for identifying responsibilities of the Owner's personnel and explanation of administrative procedures.

B. The Contractor shall also use this meeting to present all the questions they have regarding at least the following issues:
1. Construction schedule.
2. Use of areas of the site.
3. Delivery and storage.
4. Safety.
5. Security.
6. Cleaning up.
7. Subcontractor procedures relating to:
a. Submittals
b. Change orders.
c. Applications for payment.
d. Record documents.

C. Attendees shall include:
1. The Owner's Project Manager.
2. The Owner's consultants as directed by Owner's Project Manager.
3. The Contractor and its superintendent.

1.07 SECURITY PROCEDURES

A. Contractor shall limit access to the site to persons involved in the Work.

B. Contractor shall provide secure storage for materials for which the Owner has made payment and which are stored on site.

C. Contractor shall secure completed work as required to prevent loss.

D. Badge System: Park issued badge will be required for all construction crew members entering the Park. Contractor will be required to administer and monitor the badge system.

1.08 PRODUCTIVITY REPORTING

A. Refer to Section 012000 Project Schedules and Project Meetings.

1. Purpose: Reporting the pace of production of submittals and fabrication for Section 130002 Artificial Rockwork.

1.09 COORDINATION

A. If necessary, Contractor shall inform, in writing, each party involved of procedures required for coordination; Contractor shall include requirements for giving notice, submitting reports, and attending meetings.
   1. Contractor shall inform the Owner's Project Manager when coordination of its Work is required.

B. Contractor shall prepare coordination drawings where limited space available may cause conflicts in the locations of installed products, and where required to coordinate installation of products.
   1. Where space is limited, Contractor shall show plan and cross-section dimensions of space available, including structural obstructions and ceilings as applicable.
   2. Contractor shall coordinate shop drawings prepared by separate entities.
   3. Contractor shall show installation sequences when necessary for proper installation.

C. Contractor shall coordinate scheduling of paving work with Owner's Project Manager to maintain guest traffic through area during the construction period. Night pours of quick-set concrete and relocation of construction fence may be required. Relocation of construction fence shall be the total responsibility of the Contractor.

1.10 ORDER OF PRECEDENCE IN CONTRACT DOCUMENTS

A. The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce indicated results.

B. In the event an inconsistency is noted in the Contract Documents, Contractor shall notify the Owner's Project Manager according to the General Conditions.
   1. For bidding purposes relative to cost, the most expensive interpretation is to be assumed unless written clarification is given by Owner's Project Manager.
   2. Any conflict shall be brought to the attention of the Owner's Project Manager prior to the execution of the Work. Any Work completed based upon an interpretation or decision by Contractor without prior consultation with Owner's Project Manager shall be done so at the Contractor's risk. Should the interpretation or decision by the Contractor be incorrect, the Work shall be corrected at no additional cost to Owner.

C. With regards to the construction of rockwork:
   1. Building elevations, plans and sections in preference to Rockwork Model for boundary outlines of rockwork scope and interaction with building components.
   2. Rockwork Model in preference to the building elevations for three-dimensional profiles, surface carvings and projections of rockwork elements.
   3. Character Reference Guide in preference to the Rockwork Model for colors and textures.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 010310

ALTERNATES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. List of alternates.

B. Procedures for alternate work.

1.02 LIST OF ALTERNATES

A. Alternate Bid No. 1: Ride Column foundations
   1. Base Bid: As shown on Contract Documents, ride column foundation shall be formed with a square grout pocket, for ride column to be set and grouted in fill.
   2. Alternate Bid: Contractor shall substitute a corrugated pipe product, suitable to be left in place, to be used as a stay-in-place formwork. The corrugated pipe shall have a flat bottom attached so the initial concrete pour does not enter the grout pocket.

1.03 CONTRACT CONSIDERATIONS

A. Alternates:
   1. Indicate price for alternates on bid form.
   2. Include in alternate price all materials, parts and accessories required for a complete installation, regardless of whether they are mentioned in the alternate description.
   3. The Owner reserves the right to accept no alternates.
   4. Accepted alternates will be identified in the agreement.

B. Voluntary alternates will not be considered in evaluation of bids.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 ALTERNATES

A. Coordinate alternate work with related work and modify adjacent work as required.

END OF SECTION

SECTION 010400

ACCESSIBILITY FOR PERSONS WITH DISABILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes:
   1. Applicable regulations.
   2. Contractor's responsibilities for accessibility compliance.
   3. Rough-in Survey.
   4. Finished work survey.

1.02 RELATED DOCUMENTS

A. Owner-Contractor Agreement.

B. Section 010300 - Summary of Project.

C. Section 013000 - Submittals.

D. Section 018000 - Project Record Documents.

E. Diagrammatic illustrations of certain requirements in the drawings.

1.03 APPLICABLE REGULATIONS

A. California Accessibility Code, 2016.

B. International Building Code / ANSI A117.1-2009.

C. U.S. Department of Justice, 2010 ADA Standards for Accessible Design.

D. Refer to Section 010300 for all other listed applicable regulations.

1.04 SUBMITTALS

A. In accordance with Section 013000, provide to the Owner’s Project Manager the following:
   1. Certifications of Surveys described herein.

1.05 CONTRACTOR'S RESPONSIBILITIES

A. It is the Owner's desire and policy to provide full accessibility for persons with disabilities. The intent of this specification and the associated drawing is to require the Contractor to achieve accessibility to the fullest extent possible through compliance with these documents.

B. Contractor shall not knowingly install work that is not in compliance with the applicable regulations.

C. Contractor shall, at no additional cost to the Owner, and with no delay to the project, repair and/or replace, as directed by the Owner’s Project Manager, any work that is not in compliance with the contract documents or applicable regulations.

D. Field reference manuals: Have available at the project field office, and be familiar with, a copy of each of the above referenced regulations, for the duration of the project.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 DIAGRAMMATIC ILLUSTRATIONS

A. Refer to the drawing titled “General Accessibility Requirements” for diagrammatic illustrations showing placements and dimensions of selected features pertaining to Accessibility for Persons with Disabilities.
   1. The placement and dimensions shown, for the most part, are less than the regulated maximums and more than the regulated minimums in order to ensure full compliance.
   2. Other dimensions in the documents shall take precedence over the dimensions shown on the General Accessibility Requirements drawing provided that they do not create a violation of the applicable regulations. Contractor shall report to the Owner’s Project Manager any discrepancies, and acquire an approved resolution prior to proceeding.
   3. All work affected by the above applicable regulations shall comply fully with those regulations.
   4. In the absence of dimensions in the Contract Documents and regulations, notify the Owner’s Project Manager prior to starting work.

3.02 AS-BUILT SURVEYS

A. The Contractor shall be responsible for constructing all aspects of the work to comply with the Contract Documents and to report to the Owner’s Project Manager, prior to installation, any conditions discovered in the documents that are non-compliant with the accessibility regulations specified herein.
   1. The Contractor shall certify to Owner that for the following particular elements surveys have been completed and the conditions are compliant as specified.
      a. Pavements and building slabs formwork to assure that they are set properly so that required slopes and elevations will be achieved.
      b. Pavements and building slabs finished surfaces to assure that all slopes and elevations are compliant with the documents for running slopes, cross slopes, and required elevations.
      c. Plumbing fixtures rough-in dimensions and toilet and bath accessories rough framing to assure final installations will be compliant as required for accessibility.
      d. Plumbing fixtures and toilet and bath accessories to assure that all maneuvering clearances and vertical dimensions are compliant with the documents.
   2. Provide certifications after completion of stated work and prior to initiation of a new work which would be affected by the stated work not being compliant (i.e. provide survey of slab formwork prior to pouring of concrete slabs).

3.03 ADJUSTMENTS

A. Upon discovery of and in consultation with Owner’s Project Manager, Contractor shall adjust, reinstall, and/or replace any work to the satisfaction of Owner, at no cost to Owner nor any delay of the project schedule, which is not in compliance with the referenced regulations.

END OF SECTION

SECTION 012000

PROJECT SCHEDULES AND PROJECT MEETINGS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section Includes:
   1. Project Schedules
      a. Contractor's construction schedule
      b. Three-week look-ahead schedule
   2. Project Meetings

B. Contract milestone dates are defined in the Owner-Contractor Agreement.

1.02 SUBMITTALS

A. Contractor's Detailed Schedule:
   1. Contractor shall submit the Initial Schedule to the Owner's Project Manager within 7 days of the Notice to Proceed.
   2. Contractor shall submit a Detailed Schedule, coordinated with the subcontractors, to the Owner's Project Manager at the Preconstruction Conference. The Owner's Project Manager will review the document with the Contractor, and after required modifications, approve the Schedule.
   3. Each month, the Contractor shall submit an update to his Detailed Schedule reflecting job progress for the past month, including original baseline.
   4. No pay estimate will be processed unless the current month's updated schedule documents have been approved by the Owner's Project Manager.
   5. Contractor shall distribute copies of the approved schedule monthly to subcontractors and entities affected by the schedule dates. Contractor shall post the current schedule in the Field Office or meeting room.

B. Three-Week Look-Ahead Schedule:
   1. Contractor shall submit a supplemental Look-Ahead Schedule each week. This schedule is to be revised for each weekly project meeting.

C. Minutes of Progress Meetings.
   1. Minutes of meetings shall be sent by Contractor within 3 days of the meeting.

1.03 CONTRACTOR'S DETAILED SCHEDULE

A. Purpose: The primary objectives of the project scheduling program are to plan the construction activities so they may be prosecuted in an orderly and expeditious manner, utilizing CPM (Critical Path Method) scheduling methods, to provide optimum coordination between contractors, to establish the basis for measuring and monitoring individual contractor progress and overall project progress, and to detect problems for the purpose of taking corrective action.

B. Policy: The Contractor shall prepare a comprehensive Contractor's Detailed Schedule utilizing CPM methods covering the entire scope of his responsibilities. The schedule shall present the Contractor's intended pace and order of work. The Contractor shall also submit required Cost Loading needed to analyze job progress. This schedule shall be submitted to the Owner's Project Manager for review and acceptance.

C. The schedule shall be developed by the Contractor to meet project milestones as defined in the Owner-Contractor Agreement.

D. The Contractor shall prepare a Contractor Detailed Schedule produced in both network CPM and bar chart format. The network shall be a CPM (Critical Path Method) using the CPM software the

Contractor normally uses if it can meet the requirements of this section. If it does not, the Contractor must obtain CPM software that does.

E. The Contractor Detailed Schedule shall indicate:
   1. Contract Milestones
      a. Start date
      b. Completion date
   2. All field tasks
   3. Constraints between activities
   4. Construction Milestones:
      a. Pre-construction Meeting
      b. Structure Complete
      c. Permanent Enclosure
      d. Installation of Owner-Furnished / Owner-Installed and Owner-Furnished / Contractor-Installed Packages
      e. Work Under Other Contracts
      f. Mechanical Work Complete
      g. Electrical Work Complete
      h. Instruction to Owner's Personnel in Operation and Maintenance of Equipment and Systems
   5. Off-site restraints such as
      a. permits
      b. inspections
      c. approvals
   6. Availability dates
      a. Ordering dates for long-lead items by Owner and Contractor.
      b. Delivery dates for long-lead items by Owner and Contractor.
   7. Shutdowns required by the Park
   8. Other tasks and milestones as required in the Contract Documents or requested by the Owner’s Project Manager.
   9. Baseline.

F. Tasks shall be broken down into activities that allow monitoring of the monthly progress. In general, particular areas of interest shall be identified. Each area shall be broken down into activities in keeping with the general practices of the construction trade. The Contractor shall furnish the Owner’s Project Manager his Activity Code Listing. The Contractor is not restricted to the amount of detail he can use.

G. Each activity shall be developed to include as a minimum the following details:
   1. Code identification numbers (ID)
   2. Area
   3. Description
   4. Work days duration

H. Relationships between activities shall be identified with the following information:
   1. Activity ID
   2. Predecessors Activity ID
   3. Relationship Type
      a. FS - Finish to Start
      b. SS - Start to Start
      c. FF - Finish to Finish
      d. SF - Start to Finish
   4. Lag in working days

I. The Detailed Schedule shall indicate the following information in a prominent location:
   1. Project number

2. Project description
3. Contractor
4. Engineer
5. Schedule number
6. Date

J. Each schedule submittal shall include two copies of logic drawings, bar chart, area listing, relationship listing and tabular report.

K. The Schedule Bar Chart shall be time scaled and sorted by area and early start date. The bar chart shall include:
   1. Each activity on a single line containing:
      a. Item Number
      b. Activity Description
      c. Bar representing Project Duration, Early Start, Late Finish, Duration and Float
      d. Key to identify all components in the bar chart

L. The logic drawing shall include:
   1. Single box for each activity containing:
      a. Activity ID
      b. Activity Description
      c. Duration of Working Days
      d. Destination for CP Items
      e. Early Start Date
      f. Late Start Date
   2. Lines and arrows designating relationships
   3. Key to identify all components of the drawing.

M. Revisions to Schedule:
   1. Once a schedule has been approved by the Owner's Project Manager, the activities, cost loading, and dates become the baseline information against which the progress of the job is compared. To change these base lines, the Contractor shall submit a revised schedule to the Owner. Reasons for revising the schedule must be approved by the Owner's Project Manager and fall into one of the following categories:
      a. Approved Change Order(s) and/or Supplemental Agreements being incorporated into schedule.
      b. Major changes to the organization and/or management of the project that would result in an improvement to the job progress.
      c. Delays which entitles the Contractor to an extension of time pursuant to the terms of the contract.

N. Cost Loading of Schedule:
   1. Each activity in the approved schedule shall be cost loaded by WBS (Work Breakdown Structure) elements as provided by Owner's Project Manager.
   2. The Contractor shall furnish a report to show cost loading including the following information:
      a. WBS element
      b. Activity ID
      c. Description of activity
      d. List of pay items included in activity including:
         1) Pay item number
         2) Pay item description
         3) Quantity of pay item to be applied
         4) Units of pay item
         5) Unit price
         6) Total price
      e. Total cost loading of item (accumulation of "d")

3. The Owner's Project Manager will review cost loading and make recommendations to Contractor for inclusion in the monthly cost loaded schedule update.

O. Monthly Updating Procedure:
   1. Schedule updates shall be known as the Updated Contractor Schedule.
   2. Monthly project progress and cost loading that follows the approved schedule shall be submitted to the Owner's Project Manager.
   3. Identify activity progress as:
      a. C = Complete
      b. P = Percentage complete
      c. R = Remainder to complete in work days
      d. E = Elapsed duration in work days
   4. Any work in progress or planned that deviates from the approved schedule shall be incorporated into the monthly update. The Contractor shall submit to the Owner's Project Manager all information necessary, including a revised logic diagram, revised relationship listing, each of which has the changes highlighted.
   5. Comparison of approved Construction Schedule as a baseline to the Updated Contractor Schedule shall be graphically illustrated.
   6. The Contractor shall prepare a narrative report highlighting progress and pointing out activities where early start dates have slipped by more than eight days, and critical activities have slipped "any amount" from the previous month based on the approved schedule.
   7. In the case where there is slippage, the Contractor shall develop and submit a plan to the Owner's Project Manager for recovering the lost time.

P. Resource Scheduling: The Contractor shall provide any resource information requested by the Owner's Project Manager including the following:
   1. A listing of all crews, which includes:
      a. A breakdown into labor and equipment of each crew.
      b. For each type, the number of crews available.
      c. For each crew, the dates they will be available.
      d. Assignment of each crew type to be appropriate activity(s)
   2. Production Rates - A listing of forecasted production rates on key activities including embankment, subsoil excavation, stabilization, limerock, asphalt piling, concrete work, etc.
   3. The current months' updated schedule documents will not be approved by the Owner's Project Manager until all requested resource scheduling information is properly submitted by the Contractor.

1.04 CONTRACTOR'S THREE-WEEK LOOK-AHEAD SCHEDULE

A. Contractor shall submit to the Owner's Representative in the weekly meeting a Three-Week "Look Ahead" Schedule in tabular form.
   1. Each activity to be worked on shall include:
      a. Activity description
      b. Description of anticipated work
      c. Day(s) that work is to be performed
   2. For each item which, according to schedule of work, could be performed but is not planned:
      a. Activity description
      b. Float remaining
      c. Reason work is not planned

1.05 APPROVAL OF THE SCHEDULE

A. The Schedule will be submitted to the Owner's Project Manager for approval. Based on the above criteria, the Owner's Project Manager may analyze the schedule and state whether the plan is workable.

B. If the schedule requires revision, the Contractor shall revise and resubmit the schedule within 3 days.

C. Once approved the submittal will be known as the Construction Schedule. The approval of the Construction Schedule by the Owner's Project Manager does not relieve the Contractor of its obligation to complete the work within all dates set forth in the Contract Documents.

1.06 PROGRESS MEETINGS

A. Contractor shall schedule and conduct weekly progress meetings during the construction project. Contractor shall notify the Owner's Project Manager at least one week in advance of the date of the meeting; the Owner's Project Manager may attend the meetings.

B. The following are required to attend the progress meetings:
   1. Project superintendent.
   2. Major subcontractors and suppliers.
   3. Others who have an interest in the agenda.

C. Contractor shall prepare and distribute an agenda and the Three Week Look Ahead Schedule prior to the meetings; Contractor shall cover the following topics when applicable:
   1. Minutes of previous meeting.
   2. Status of submittals and impending submittals.
   3. Off-site fabrication and delivery schedules.
   4. Review of the actual progress as documented in the Three Week Look Ahead Schedule.
   5. Actual and anticipated delays, their impact on the schedule, and corrective actions taken or proposed.
   6. Progress expected to be made during the next period.
   7. Actual and potential problems.
   8. Status of corrective work ordered by the Owner's Project Manager.

D. Contractor shall record minutes and distribute copies to the Owner's Project Manager, all participants and to all entities affected by decisions made.

1.07 PRODUCTIVITY REPORTING ARTIFICIAL ROCKWORK

A. Contractor shall submit to the Owner’s Representative weekly a Productivity Report in tabular form.
   1. Purpose: Reporting the pace of production of fabrication for Section 130002 Artificial Rockwork.
   2. Based on on-site construction start date and substantial completion date, establish weekly production rate goals.
   3. Fabrication of both shop and field fabricated components.
      a. Man-hours.
      b. Square feet of surface area of shotcrete applied in previous week.
      c. Percentage of shotcrete installed compared to total estimated volume to be produced in square feet.
      d. Estimated square feet of finish treatments including painting.
      e. Percentage of finish treatments installed compared to total estimated volume to be produced in square feet.

1.08 PRE-CONSTRUCTION MEETING MINUTES

A. Contractor shall prepare and distribute minutes from all pre-construction meetings required by subsequent technical specification sections. Contractor shall cover the following topics at a minimum:
   1. Attendees
   2. Discussed installation procedures
   3. Action items requiring follow-up
   4. Schedule implications

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 013000

SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section Includes:
   1. Preparing and processing of submittals for review and action.
   2. Preparing and processing of informational submittals.

B. The Contractor shall prepare and submit within 30 days after authorization to proceed a schedule showing the required dates of all submittals. The Schedule shall be revised and resubmitted to Owner's Project Manager for approval when requested.
   1. The schedule shall indicate that all shop drawings required prior to installation shall be submitted within 90 days of Notice to Proceed.

C. Contractor shall submit the following as required by the Contract Documents for the Owner's Project Manager review and action:
   1. Shop drawings.
   2. Structural design information.
   3. Product data.
   4. Samples.
   5. Mockups and first articles.
   6. Submittals indicated as "for approval."
   7. Submittals for which procedures are not defined elsewhere.

D. Contractor shall submit the following as informational submittals:
   1. Certificates.
   2. Coordination drawings.
   3. Reports.
   4. Qualification statements for manufacturers/installers.
   5. Submittals indicated as "for information only."

E. Specific submittals are described in individual sections of the Specifications.

F. Contractor shall not commence Work which requires review of any submittals until it receives such submittals returned with an acceptable action unless approved otherwise by the Owner's Project Manager. If the Contractor does commence work for any reason prior to receipt of a submittal returned with an acceptable action, the Contractor does so at its risk.

G. Contractor shall submit all submittals to Owner's Project Manager as described in the General Contract Conditions or as otherwise directed by Owner's Project Manager.

H. Contractor shall not submit substitute items that have not been approved under the Contract Documents.

I. Contractor shall not include requests for substitution (either direct or indirect) on submittals; Contractor shall comply with procedures for substitutions specified in the Contract Documents.

J. Related Sections: The following are described elsewhere in Division 01:
   1. Progress of work submittals:
      a. Contractor's construction schedules.
   2. Quality control submittals:
      a. Inspection reports.
      b. Test reports.
   3. Product submittals:
      a. Product option submittals.

b. Requests for substitution.
c. Operating and maintenance data.
d. Warranties.
e. Maintenance materials and tools.

4. Contract closeout submittals.
   a. Certificate of occupancy.
   b. Project record documents.

1.02 DEFINITIONS

A. “Shop Drawings” are drawings and other data prepared by the entity who is to do the work, specifically to show a portion of the work.
   1. Shop drawings also include:
      a. Product data specifically prepared for this Project.
      b. Shop or plant inspection and test reports, when made on specific materials, products, or systems to be used in the work.

B. “Product data submittals” are standard printed data which show or otherwise describe a product or system, or some other portion of the work.
   1. Product data submittals also include:
      a. Performance data on product or system to be provided.
      b. Selection data showing standard colors.
      c. Wiring diagrams, when standard for all products of that type.

C. “Samples” are actual examples of the products or work to be installed.

D. “Informational Submittals” are identified in the Contract Documents as submitted for information only.

E. “Mockups” should be interpreted as a prototype for on-site modification to be completed and reviewed prior to beginning final work.

F. “First Articles” should be interpreted as a finished example for use in final installation after approvals.

1.03 FORM OF SUBMITTALS

A. Electronic Submittals – Contractor shall host and maintain a project web site for the distribution and management of electronic submittals.
   1. Contractor shall submit product literature or detailed description of the software used to manage electronic submittals for review and approval by the Owner’s Project Manager.
   2. Software shall be capable of the following:
      a. E-mail notification that submittals have been posted
      b. Tracking submittal and review dates.
      c. Storage capacity to accommodate all electronic submittals for the project
      d. Storage of site photos
      e. Publishing a report describing the status of all submittals
   3. Architect will be responsible for downloading all materials, reviewing them, and returning them electronically to the project web site with the appropriate review comments.
   4. Contractor shall provide electronic submittals of the following items. No paper submittals will be accepted. Electronic submittals shall include evidence of all required Contractor review.
      a. Shop Drawings
      b. Product Data
      c. Certificates
      d. Inspection or test reports
      e. Photographs of all mockups and first articles
   5. Sheet Format
      a. Electronic format for all drawing submittals shall be PDF

b. Electronic format for all photo submittals shall be JPEG

6. Sheet sizes shall be one of the following. Request approval of any other size format prior to submittal.
   a. 8 ½' x 11"
   b. 11" x 17"
   c. 24" x 36"
   d. 30" x 42"

B. Samples: Three (3) sets of each unless noted otherwise in specific section.
   1. One set will be returned.

C. Mock-ups: Contractor shall build mockups in location approved by Owner's Project Manager. Photographs are to be submitted for tracking review comments.

D. First Articles: Contractor shall build first articles in location approved by Owner's Project Manager. Photographs are to be submitted for tracking review comments.

E. If additional sets are needed by other entities involved in work represented by the samples, Contractor shall submit them with the original submittal.

1.04 COORDINATION OF SUBMITTALS

A. Contractor shall coordinate submittals and activities that must be performed in sequence, so that the Owner's Project Manager has sufficient information to properly review the submittals.

B. Contractor shall coordinate submittals of different types for the same system so that the Owner's Project Manager has sufficient information to properly review each submittal.

C. Contractor shall stamp submittals indicating that the submittals have been reviewed prior to submission.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 TIMING OF SUBMITTALS

A. Contractor shall deliver each submittal requiring approval in time to allow for adequate review and processing time, including re-submits if necessary; failure to allow adequate time will not be considered as grounds for an extension of the contract time.

B. Contractor shall deliver each informational submittal prior to start of the work involved, unless the submittal is of a type which cannot be prepared until after completion of the work; Contractor shall deliver promptly after completion of the work any submittal for which work completion is required.

C. If a submittal must be processed within a certain time to maintain the progress of the work, Contractor shall state such time clearly on the submittal.

D. Contractor shall allow a minimum of 10 business days after receipt for the first processing of each submittal. Contractor shall allow more time when submittals must be coordinated with later submittals.

E. Contractor shall allow a minimum of 10 business days for processing of re-submittals.

F. If a submittal must be delayed for coordination with other submittals not yet submitted, the Owner's Project Manager may at its option either return the submittal with no action or notify the Contractor of the other submittals which must be received before the submittal can be reviewed.

3.02 SUBMITTAL PROCEDURES - GENERAL

A. Contractor Review: Contractor shall sign each copy of each submittal and shall either certify compliance with the requirements of the Contract Documents or advise Owner's Project Manager in writing of all points upon which the submittal does not conform to these requirements.

B. Preparation of Submittals:
   1. Contractor shall label each copy of each submittal with the following information:
      a. Project name.
      b. Date of submittal.
      c. Contractor's name and address.
      d. Subcontractor's name and address.
      e. Supplier's name and address.
      f. Manufacturer's name.
      g. Specification section where the submittal is specified.
      h. Numbers of applicable drawings and details.
      i. Other necessary identifying information.
   2. Contractor shall pack submittals suitably for shipment.
   3. Submittals to receive action marking by the Owner's Project Manager: Contractor shall provide blank space on the label or on the submittal itself for action marking of a minimum 4 inches wide by 5 inches high.

C. Transmittal of Submittals:
   1. Submittals will be accepted from the Contractor only. Submittals received from other entities will be returned without review or action.
   2. Submittals received without a transmittal form will be returned without review or action.
   3. Transmittal form: Contractor shall use a form acceptable to the Owner's Project Manager; Contractor shall provide space on the form for:
      a. Project name.
      b. Submittal date.
      c. Transmittal number.
      d. Specification section number.
      e. To:
      f. From:
      g. Contractor's name.
      h. Subcontractor's and supplier's names.
      i. Manufacturer's name.
      j. Submittal type (shop drawing, product data, sample, informational submittal).
      k. Description of submittal.
      l. Records of distribution.
      m. Action marking.
      n. Comments.
   4. Contractor shall fill out a separate transmittal form for each submittal and include the following:
      a. Other relevant information.
      b. Requests for additional information.

D. Contractor shall deliver submittals to Owner's Project Manager by hand or by overnight delivery service.

3.03 SHOP DRAWINGS

A. Content: Contractor shall include the following information:
   1. Dimensions, at accurate scale.
   2. All field measurements that have been taken, at accurate scale.
   3. Names of specific products and materials used.
   4. Details, identified by contract document sheet and detail numbers.
   5. Compliance with the specific standards referenced.
   6. Coordination requirements showing relationship to adjacent or critical work.
   7. Name of preparing firm.

B. Preparation:

1. Contractor shall identify as indicated for all submittals.
2. Space for Owner's Project Manager’s action marking shall be adjacent to the title block.

3.04 PRODUCT DATA

A. When product data submittals are prepared specifically for this Project, Contractor shall (in the absence of standard printed information) submit such information as shop drawings and not as product data submittals.

B. Content. Contractor shall:
   1. Submit manufacturer's standard printed data sheets.
   2. Identify the particular product being submitted; submit only pertinent pages.
   3. Show compliance with properties specified.
   4. Identify which options and accessories are applicable.
   5. Include recommendations for application and use.
   6. Show compliance with the specific standards referenced.
   7. Show compliance with specified testing agency listings; show the limitations of their labels or seals, if any.
   8. Identify dimensions which have been verified by field measurement.
   9. Show special coordination requirements for the product.

3.05 SAMPLES

A. Requirements. Contractor shall:
   1. Provide samples that are the same as proposed product.
   2. Where unavoidable variations must be expected, submit “range” samples, a minimum of 3 units, and describe or identify variations among units of each set.
   3. Where selection is required, provide a full set of all options.
   4. Where products are to match a sample prepared by other entities, prepare a sample to match.

B. Preparation. Contractor shall:
   1. Attach a description to each sample.
   2. Attach name of manufacturer or source to each sample.
   3. Where compliance with specified properties is required, attach documentation showing compliance.
   4. Where there are limitations in availability, delivery, or other similar characteristics, attach description of such limitations.
   5. Where selection is required, the first submittal may be a single set of all options; after return of submittal with selection indicated, submit standard number of sets of selected item.

C. Contractor shall keep final sample set(s) at the project site, available for use during progress of the work.

3.06 MOCKUPS

A. Requirements. Contractor shall:
   1. Provide mockups per subsequent specification sections and as identified in the drawings.
   2. Mockups indicating an assembly are to be constructed as a full assembly which may require coordination between various trades prior to submitting mockup for review.
   3. Assume mockups are for on-site modification and are a consumable.
      a. In limited instances, Owner’s Project Manager may approve the installation of mockups into final work.

B. Contractor shall keep all approved mockups at the location of work for reference during progress of the work.

3.07 FIRST ARTICLES

A. Requirements. Contractor shall:
   1. Provide first articles per subsequent specification sections and as identified in the drawings.
   2. Provide example for review and approval before commencing work on additional identical elements.
   3. Assume first articles are for use in the final installation.

3.08 REVIEW OF SUBMITTALS

A. Submittals for approval will be reviewed by Owner's Project Manager, marked with appropriate action, and returned.

3.09 RETURN, RESUBMITTAL AND DISTRIBUTION

A. All hard copy submittals shall be returned only by 2-day delivery.
   1. Overnight delivery only allowed if permission is granted by Owner’s Project Manager prior to sending.

B. Contractor shall perform re-submittals in the same manner as original submittals; Contractor shall indicate all changes other than those requested by Owner’s Project Manager and/or other designated Owner’s representatives.

C. Distribution: Contractor shall:
   1. Distribute returned submittals to all subcontractors and suppliers involved in work covered by the submittal.
   2. Make extra copies for operation and maintenance data submittals, as required.
   3. Make one copy for Owner’s project record documents.

3.10 TURN OVER OF RECORD SUBMITTALS

A. Contractor to retain (2) copies of all submittals in a binder to be turned over to Owner’s Project Manager at closeout. Information in binder to include where each product was purchased with contact information.

B. Contractor to provide Owner’s Project Manager two (2) DVD copies of all submittals.
   1. Information to include where each product was purchased with contact information.

END OF SECTION

SECTION 014000

QUALITY CONTROL PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section Includes:
   1. General quality control activities.
   2. Procedures for the following
      a. Preparation and maintenance of schedule of quality control activities.
      b. Testing and evaluation of test results.
      c. Inspections.
   3. Procedures for quality control activities performed by:
      a. Independent testing agencies.
      b. Contractor.
   4. Procedures for submittal of quality control documentation.

B. Quality control activities required are specified in other sections.

C. General Contract Conditions provide additional requirements for testing, inspections, and approvals.

D. The cost of quality control activities specifically designated as paid for by the Owner either on the drawings or in other specification sections is not to be included in the Contract Sum. Otherwise, the cost of all quality control activities required by specifications, drawings or scope narrative shall be borne by Contractor.

1.02 TESTING AND INSPECTION PROCEDURES

A. When portions of the work are required by the Contract Documents or by governing authorities to be tested, inspected, or approved, such tests, inspections, and approvals shall be made at the appropriate time.

B. Unless otherwise indicated, all tests, inspections, and approvals shall be made by an independent testing agency, the appropriate public authority, or other entity acceptable to the Owner’s Project Manager.

C. Unless otherwise specified, the Contractor shall arrange for all tests, inspections, and approvals to be made, and shall pay the costs of all tests, inspections, and approvals, including related costs due to such tests, inspections, and approvals.

D. The Contractor shall notify the Owner’s Project Manager of the time and place tests and inspections are to be made so the Owner’s Project Manager may have adequate time at the discretion of the Owner's Project Manager, to arrange to observe such procedures.

E. If the Contract Documents require that the Owner observe tests, inspections, or approvals, the Owner will do so at no additional cost to the Contractor, provided such tests, inspections, or approvals are to be conducted at the project site.
   1. When witnessing of such tests and inspections by the Owner at locations other than the project site is specified, the Contractor shall bear all costs relating to the travel by the Owner to the testing or inspection location.

F. The Owner shall pay for tests, inspections, and approvals which become requirements after bids are received or negotiations concluded.

G. If the Owner’s Project Manager gives the Contractor written instruction to perform additional testing or inspection not already included in the Contract Documents, the Contractor shall arrange

for such additional testing or inspection. The Owner shall pay for such tests and inspections except as provided in the following paragraphs.

1. If such additional procedures show that portions of the work do not comply with the Contract Documents, the Contractor shall pay all costs arising thereafter due to such noncompliance including those due to repeating such procedures as well as payment for the services and expenses of the Owner.

H. Unless otherwise indicated, the Contractor shall obtain all certificates of testing, inspection, and approval and shall promptly deliver them to the Owner's Project Manager.

I. Independent testing agencies, whether employed by the Owner or the Contractor, may not change the requirements of the Contract Documents and may not approve any portion of the work.

J. Employment of testing agencies, by the Owner or the Contractor, shall not relieve the Contractor of its obligation to perform the Work in accordance with the Contract Documents.

1.03 DEFINITIONS RELATING TO TESTING

A. Owner's Testing Agency: Any independent testing and inspection agency employed by Owner to perform certain quality control activities.

B. Reference Standard: Any document incorporated into the specification by reference rather than by inclusion of complete text, including, but not limited to, voluntary specifications prepared by standards organizations and industry organizations.

1.04 REFERENCE STANDARDS

A. Reference Standards - General:
   1. Contractor shall comply with the edition of the standard indicated; if a date is not indicated, Contractor shall comply with the edition in effect as of the date of Owner-Contractor Agreement.
   2. Compliance with standards which are revised or reissued after that date will not be required unless incorporated into the Contract Documents by Change Order or Addendum.
   3. Where applicable codes, laws, or regulations require editions of different dates, Contractor shall obtain instructions from the governing authorities as to which edition is required.

B. The requirements of Reference Standards are binding on the Contractor, as if they were copied into the Contract Documents, but no provisions of Reference Standards shall alter the contractual relationship of the parties to the Contract.

1.05 QUALITY CONTROL SUBMITTALS

A. Schedule of Quality Control Activities:
   1. Contractor shall submit such schedule as part of Contractor's detailed construction schedule.
   2. Contractor shall revise such schedule as required by the Owner's Project Manager, to coordinate with the activities of the Owner's testing agency.
   3. Contractor shall distribute such schedule to:
      a. The Owner's Project Manager.
      b. The Owner's consultants.
      c. Each entity performing work for which quality control activities are specified.

B. Reports: Contractor shall provide certified copies of reports.
   1. Unless otherwise indicated, Contractor shall submit such reports for review by the Owner's Project Manager.
   2. Contractor shall submit reports not later than the date of application for payment for the Work to which the quality control activity relates.
   3. Reports shall be prepared by the entity performing the quality control activity.

4. Contractor shall submit copies directly to governing authorities when so directed and as required by law.
5. When the Contractor employs an independent testing agency, Contractor shall submit copies directly to the Owner's Project Manager.
6. Contractor shall include the following information in all types of reports:
    a. Date of report.
    b. Project name (and number, if applicable).
    c. Description of the quality control activity.
    d. Name, address, and telephone number of entity performing activity.
    e. Date quality control activity was performed.
    f. Specification section(s) involved.
    g. Basis for evaluation (test method, etc.).
    h. Results of conclusions, including evaluations and interpretations.
    i. Title, name, and signature of person performing activity.
7. Contractor shall include the following information in all test reports:
    a. Locations from which samples were taken, if any.
    b. Ambient conditions at time of activity.
    c. Recommendations for retesting, if any.

1.06 QUALITY ASSURANCE

A. Qualifications of testing and inspection personnel shall be as indicated in individual sections.

B. Testing Equipment shall be calibrated at reasonable intervals with devices of an accuracy traceable to either the National Bureau of Standards (NBS) standards or to accepted values of natural physical constants.

1.07 COORDINATION WITH OTHER ENTITIES

A. Contractor shall cooperate with other entities performing quality control activities.

B. Contractor shall provide samples of materials and design criteria as indicated and when requested.

C. Contractor shall provide other assistance, equipment, tools, and storage facilities as specified.

D. If desired, Contractor shall make arrangements with those entities and pay for additional similar or related testing or inspection required for the Contractor's use or convenience.

1.08 SEQUENCING AND SCHEDULING

A. Contractor shall prepare a schedule of quality control activities required. Contractor shall:
    1. Include activities of the Owner's testing agencies.
    2. Provide the following information for each activity:
        a. Specification section number.
        b. Description of the activity.
        c. Identification of test or inspection methods.
        d. Enumeration of results required.
        e. Number of tests required.
        f. Number and type of samples to be taken, if any.
        g. Starting time of activity.
        h. The date that the work will be ready for access by the Owner's testing agency.
        i. Elapsed time required for activity.
        j. Entity responsible.
        k. Special requirements for activity.

B. Contractor shall coordinate quality control activities to avoid delay and to make it unnecessary to uncover work for testing or inspection. If Work has to be uncovered it shall be at the Contractor's expense.

C. Contractor shall notify the Owner's testing agencies two (2) weeks prior to commencement or completion of work which is to be tested or inspected; whichever is applicable.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL QUALITY CONTROL REQUIREMENTS

A. Contractor shall provide Work at or above the quality specified in the General Conditions; all work shall be also performed in a good and workmanlike manner, free from defects, equaling or exceeding industry standards for such Work.
   1. Where codes, laws, or regulations require Work of higher quality or performance, Contractor shall provide Work complying with those codes, laws, and regulations.
   2. Where two or more quality provisions of the Contract Documents conflict, Contractor shall comply with the most stringent requirement; where requirements are different but apparently equal, and where it is uncertain which requirement is most stringent, Contractor shall obtain clarification from the Owner's Project Manager before proceeding.
   3. Actual quality may exceed the specified quality; Contractor shall verify that such differences are acceptable to the Owner's Project Manager (other criteria may make excessive quality undesirable).

B. Contractor shall control products, suppliers, manufacturers, site conditions, installers, and workmanship in such a manner as to produce work of the specified quality.

C. Contractor shall comply with manufacturers' instructions and recommendations. Contractor shall:
   1. Keep a record of instruction and recommendations which supplement or conflict with the manufacturers' written instructions.
   2. When manufacturers' instructions and recommendations conflict with the Contract Documents, obtain clarification from the Owner's Project Manager before proceeding.

D. Contractor shall use installers who are capable of producing work of the specified quality.

E. Contractor shall perform all quality control activities specified unless indicated to be performed by other entities.

3.02 TESTING

A. Contractor shall:
   1. Perform tests specified.
   2. When results of tests are unsatisfactory, make all changes or repairs necessary, and retest.
   3. Submit written report of each original test and of each retest.

3.03 INSPECTING

A. Contractor shall:
   1. Perform inspections specified.
   2. When inspections reveal unsatisfactory Work, make all changes or repairs necessary, and re-inspect.
   3. Submit written report of each original inspection and each re-inspection.

3.04 PROTECTION AND REPAIR

A. Contractor shall:
   1. When Work is uncovered during quality control activities, provide protection from damage.
   2. Correct Work damaged by quality control activities to the satisfaction of the Owner's Project Manager; if repair is unacceptable or not possible, replace affected Work.

END OF SECTION

SECTION 014600

STRUCTURAL TESTS AND SPECIAL INSPECTIONS

PART 1 - GENERAL

1.01 SCOPE

A. The purpose of this inspection, as required by the applicable Building Code, is to govern the quality, workmanship and requirements for the materials of the structure and its components and to assure that good practices are followed in constructing the project in accordance with the design and the construction documents in order to assure the public of the safe construction and subsequent use of the structure.

1.02 RELATED DOCUMENTS

A. The general provisions of the contract, including General Conditions, Supplementary Conditions and General Requirements apply to the work specified in this Section.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 033000: Cast-in-Place Concrete

B. Section 042000: Unit Masonry Assemblies

C. Section 051200: Structural Steel Framing

D. Section 053100: Steel Decking

E. Section 130002: Artificial Rockwork

1.04 RESPONSIBILITY OF CONTRACTOR

A. This testing and inspection does not relieve the Contractor of his responsibility to do the work properly in accordance with the Contract Documents.

B. This inspection does not relieve the Contractor of his responsibilities to carry out his quality control inspections and testing.

1.05 QUALIFICATIONS OF TESTING AND INSPECTING AGENCY

A. The Testing and Inspecting Agency shall be an established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved in accordance with the rules of the board of building standards, and these qualifications must be acceptable to the enforcing agency having jurisdiction for this project.

B. If the quality of testing and inspection performed by the Testing and Inspecting Agency is not as specified herein, the Owner’s Project Manager, the Architect and the Structural Engineer of Record may recommend his removal from the project to the Enforcing Agency.

1.06 OTHER REQUIREMENTS

A. The Contractor shall cooperate with and assist the Testing and Inspecting Agency in performing the inspection duties as specified below. The Testing and Inspecting Agency shall have free access to the project at all times.

B. The cost of employing the Testing and Inspecting Agency shall be the responsibility of the Owner.

C. The Testing and Inspecting Agency shall be responsible to the Owner.

D. Final interpretation of the Contract Documents shall rest with the Architect and the Engineer.

E. The Testing and Inspecting Agency shall be totally familiar with the intent, the content and the provisions of the Contract Documents relating to the part of the project under the agency's testing and inspection responsibility.

1.07 DEFINITIONS

A. Special Inspection: Inspection of materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved construction documents and referenced standards.

B. Special Inspection, Continuous: The full-time observation of work requiring special inspection by an approved inspector who is present in the area where the work has been or is being performed and at the completion of the work.

C. Special Inspection, Periodic: The part-time or intermittent observation of the work requiring special inspection by an approved special inspector who is present in the area where the work has been or is being performed and at the completion of the work.

D. Engineer of Record:
EDM Incorporated
220 Mansion House Center
St. Louis, MO 63102
T: 314-231-5485
F: 314-231-8167

E. Structural Observation: The visual observation of the structural system by a registered design professional for general conformance to the approved construction documents at significant stages and at the completion of the structural system as defined, shown and detailed on the structural documents. Structural observation does not include or waive the responsibility for the tests and inspection required herein.

1.08 STRUCTURAL OBSERVATION BY ENGINEER OF RECORD

A. The Engineer of Record, based on the progress of the work, will visit the Project periodically and observe in general the Project's conformance with the Contract Documents and the design intent. Periods where such visits are warranted are indicated in Part 3 of this Specification Section.

B. Structural Observations by the Engineer of Record do not substitute for the required special inspection specified herein.

C. The on-site agent of the Testing and Inspecting Agency shall accompany the Engineer of Record during his observation of the Project.

D. The Contractor shall inform the Owner’s Project Manager, Architect and the Engineer of Record of the construction progress of the Project and indicate to the Engineer of Record when such visits should be scheduled.

PART 2 - PROCEDURES

2.01 GENERAL PROCEDURES

A. The Contractor shall advise the Testing and Inspecting Agency in advance of construction schedules and planned operations in order to assure timely and appropriate testing, observation and inspection of items specified below.

B. The Testing and Inspecting Agency shall cooperate with the Contractor, and shall refrain from running the job for the Contractor, as this is expressly not part of the Testing and Inspection Function.

C. The Testing and Inspecting Agency shall immediately alert the Contractor of all discrepancies and deviations from the Contract Documents.

D. The Contractor shall, upon being informed by the Testing and Inspecting Agency, immediately cause to eliminate such discrepancies and deviations from the Contract Documents.

E. Re-test and re-inspect those assemblies, fabrications, installations and components of the structure which are found not acceptable upon the initial testing and inspection and those assemblies, fabrications, installations and components of the structure which the Engineer of Record finds necessary.

F. The Contractor will conduct certain preconstruction conferences as specified below and in Specification Sections listed in paragraph "Related Work Specified Elsewhere" above. The Contractor shall coordinate and schedule these conferences. The agent in charge for the Testing and Inspecting Agency assigned to the Project shall be present during these preconstruction conferences.

G. The Engineer of Record will conduct periodic structural observation at certain stages of the Project. The inspector of the Testing and Inspecting Agency shall be present during these observations.

2.02 SPECIAL INSPECTION REQUIREMENTS

A. The statement of special inspections and a list of items, elements, components and structures are defined herein, in the structural General Notes and on the structural drawings.

B. Special inspectors of the Testing and Inspecting Agency shall submit reports as herein specified.

C. Special inspectors of the Testing and Inspecting Agency shall bring discrepancies, deviations and unacceptable items to the immediate attention of the contractor for correction and to the immediate attention of the Engineer of Record.

D. If the discrepancies are not corrected, the discrepancies should be brought to the attention of the building official and to the attention of the Owner’s Project Manager and the Engineer of Record.

E. A final report documenting required special inspections and correction of any discrepancies noted shall be submitted to the Owner’s Project Manager, the Architect and the Engineer of Record. Same report shall be submitted to the building official prior to the issuance of a Certificate of Occupancy.

2.03 REPORTING

A. The Testing and Inspecting Agency shall submit reports to the governing building authority having jurisdiction over the Project, the Owner’s Project Manager, the Architect and the Engineer of Record of the Project.

B. Inspection Reports shall be submitted within 24 hours of the date and time of the inspection.

C. Testing and inspection reports shall be kept on file by the Testing and Inspecting Agency until such time when the Certificate of Occupancy is issued and the Owner has accepted the Project.

2.04 FINAL STATEMENT OF COMPLIANCE

A. Upon completion of the building or structure and prior to the issuance of a Certificate of Occupancy, a signed and sealed statement by the Testing and Inspecting Agency must be submitted to the building official, the Owner’s Project Manager, the Architect and the Engineer of Record for the Project stating that the part of the Project under this agency's testing and inspection responsibilities has been constructed in accordance with the Contract Documents. This statement shall be in accordance with the governing codes and standards.

2.05 PRE-CONSTRUCTION CONFERENCE

A. The Contractor is responsible for scheduling Pre-Construction Conferences as required in the Specification Sections.

B. The following participants will attend the various Pre-Construction Conferences:
   1. Owner's Project Manager
   2. Concrete Supplier

3. Testing and Inspection Agency representative
4. Concrete Contractor's Project Manager
5. Structural Engineer of Record
6. Masonry Contractor’s Project Manager
7. Steel Fabricator
8. Steel Erector’s Project Manager

C. The representatives listed above should be those who will participate in the day-to-day construction activities of the Project and who would be responsible for the quality of construction.

PART 3 - EXECUTION

3.01 TESTING

A. Refer to Specification Section 033000 – Cast-In-Place Concrete and the Structural drawings for detailed requirements.

B. Refer to Specification Section 042000 – Reinforced Unit Masonry and the Structural drawings for detailed requirements.

C. Refer to Specification Section 051200 – Structural Steel Framing and the Structural drawings for detailed requirements.

D. Refer to Specification Section 130002 – Artificial Rockwork.

END OF SECTION

SECTION 015000

TEMPORARY FACILITIES AND SERVICES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section Includes:
   1. Temporary utilities.
   2. Protective facilities.
   3. Employee facilities.
   4. Administrative facilities.
   5. Temporary services.
   6. Required temporary facilities and services include but not are not limited to:
      a. Drinking water facilities.
      b. Dust control services.
      c. Existing property protection.
      d. Fire protection facilities, other than piped utilities.
      e. Meeting room with conference table for weekly meeting.
      f. Public protective facilities required by law.
      g. Site fence.
      h. Telephone service.
      i. Temporary enclosures for general building heating.
      j. Temporary enclosures for protection from weather.
      k. Waste disposal service.
      l. Temporary water service.
         1) Contractor shall not include water service or sewer usage charges for water obtained from existing service; Contractor shall take precautions to conserve water.
      m. Use of permanent water service.
      n. Piped temporary fire protection facilities.
      o. Temporary electrical service, except extension cords.
         1) Contractor shall not include electric service usage charges for power obtained from existing service; Contractor shall take precautions to conserve power.
      p. Temporary lighting.
      q. Use of permanent electrical systems.
      r. Provide and coordinate for temporary access to the site.
         1) All traffic control programs must be approved by Owner's Project Manager.

1.02 DEFINITIONS

A. Temporary Facilities: Construction, fixtures, fittings, and other built items required to accomplish the work but which are not incorporated into the finished work.

B. Temporary Utilities: A type of temporary facility; primary sources of electric power, water, etc., obtained from main distribution systems, or temporary sources constructed for the project, but not including the fixtures and equipment served.

C. Temporary Services: Activities required during construction which do not directly accomplish the work.

1.03 QUALITY ASSURANCE

A. Contractor shall comply with requirements of governing authorities as to type, quantity, location, and use of temporary facilities.

B. Contractor shall comply with requirements of governing authorities, as to type and frequency of temporary services.

C. Contractor shall comply with requirements of public utilities affected.

1.04 PROJECT CONDITIONS

A. Use of permanent facilities prior to substantial completion is subject to the approval of the Owner's Project Manager and conditions.
   1. Each permanent facility used for construction purposes shall be operated, maintained, and protected during such use by the original installer.
   2. Specified warranties shall not be reduced or voided by temporary use.

1.05 SEQUENCING AND SCHEDULING

A. Contractor shall maintain facilities until not needed or until shortly before substantial completion and remove facilities before substantial completion, except where use of permanent facilities is allowed.

B. Contractor shall change over to use of permanent facilities, when applicable, as soon as possible, except when use of permanent facilities is not allowed.

1.06 OWNER OPTION FOR GRAPHIC DECORATION

A. Owner maintains the right to paint colors and/or graphics on the surfaces of the fence, trailers, shacks, or sheds which are in public view.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Contractor shall provide materials which are both suitable for the use and durable enough to withstand the use and abuse to be expected.

2.02 TEMPORARY UTILITIES

A. Temporary Water Service:
   1. Water adequate for demand of construction operations will be provided by Owner, unless otherwise noted in Contract Documents.
   2. Piped water service:
      a. Contractor shall not use permanent piping system to distribute non-potable water.
      b. Contractor shall disinfect temporary piping before use.
      c. Contractor shall provide temporary piping from the existing water system as required for construction activities.

B. Temporary Power:
   1. Electricity adequate for demand of construction operations will be provided by Owner unless otherwise noted in Contract Documents.
   2. Electrical service. Contractor shall:
      a. Extend temporary feeder from existing distribution system.
      b. Provide disconnect at connection to service.
      c. Provide service conductors and equipment.

2.03 PROTECTIVE FACILITIES

A. Fire Protection Facilities: Contractor shall provide at least the temporary facilities required by the authorities having jurisdiction.
   1. Fire extinguishers installed in the completed building shall not be used during construction.
   2. Contractor shall put permanent facilities into operation as soon as possible.

B. Temporary Site Fence: Refer to drawings for location and type of temporary site fence.
   1. General:
      a. Contractor shall design and install temporary fence framing to meet applicable codes for wind bracing and to prevent easy access to site by people and animals.

b. Contractor shall provide fencing along entire perimeter of project limit line unless noted otherwise in Contract Drawings.
c. Contractor shall provide gates as required for access.
d. Relocation of fence may be required for the facilitation of construction activities. Contractor to provide all labor/materials required for relocation. Cost of labor/materials shall be the responsibility of the Contractor.
e. Contractor shall not remove the site fence until other security facilities, either temporary or permanent, are in place and in operation.
f. Contractor shall not penetrate any existing pavements without prior approval by Owner's Project Manager.
g. Contractor shall maintain temporary fences in appropriate appearance and working order. Make repairs as directed by the Owner's Project Manager.
h. Owner maintains the right to paint colors and/or graphics on the surfaces of the fence, trailers, shacks, or sheds which are in public view.

2. Chain Link Fence: Shall be 8 feet high, hot-dip zinc-coated; wire diameter: 0.148 inch (9 gage); mesh size: 2 inches.
   a. Framing: Provide no less than top rails, bottom tension wires, brace rails at each termination, corner posts, posts at 10'-0" o.c. maximum and gates as required by construction activities or/and local officials having jurisdiction.
   b. All fencing, including gates, adjacent to public access shall include scrim screen material.
      1) Basis-of-Design for Scrim material: "Construction Fence Screen" Knitted HDPE High Density Polyetheleneby Collins Company, 5470 Daniels Street, Chino, CA, 91710; Phone: 800-222-4348; fax: 909-548-6908.
      2) Alternate Manufacturer: **"**Supreme Mesh Vinyl", by Fence Fabric, website: www.fencefabric.com; phone: (888) 336-2350. Approved equals per Section 01600.
      3) Fabric to be wind permeable; include reinforced, sewn edges. Material Weight: 145 grams per square meter.
      4) Include heavy-duty grommets and ultra-violet light stabilized zip ties; spacing as required to meet wind-load design.
      5) Include all required mounting hardware to securely attach scrim to fence, in accordance with manufacturer's recommendations.
      6) Scrim shall have graphics printed on the public side. Artwork to be provided by the Owner's Project Manager. Provide for up to three differing images.
      7) Provide a double layer of the screen material; the second layer shall lap over the top chain link substrate.
      8) Screen Material Color: As selected by Owner's Project Manager / Architect from the manufacturer's standard colors.

3. Orange Mesh Fence:
   a. Contractor shall provide capped rebar stacks with orange open structure plastic fencing.
   b. This fencing is not acceptable to be used within the view of Park guests.

C. Existing Property Protection: Contractor shall provide fixed barriers to prevent damage due to construction machinery, vehicles, and adjacent work, and provide for existing buildings to remain, pursuant to the site demolition plan.

D. Temporary Road Construction Protection: Contractor shall provide the following items as required to maintain an open service drive accessible by emergency vehicles at all times during construction.
   1. Traffic control devices including temporary signs, barricades, and cones.
   2. Engineered steel cover plates over open trenches.
   3. Flagmen are required when construction requires unscheduled temporary closure of service drive.

2.04 EMPLOYEE FACILITIES

A. Temporary Lighting: Contractor shall provide at least the lighting required by law.

B. Toilet Facilities: Contractor shall provide temporary toilet facilities.
   1. Contractor shall clean and maintain toilet facilities, which shall be enclosed and weather proof and kept in sanitary and approved condition.
   2. Contractor shall provide toilet tissue for each facility at all times.
   3. After temporary toilet facilities become unnecessary, Contractor shall remove such temporary facilities from Owner's premises.

C. Parking Facilities:
   1. The Owner’s Project Manager will designate the parking areas.

2.05 ADMINISTRATIVE FACILITIES

A. Meeting Room: Contractor shall provide space in one of the Contractor's field offices on site. Contractor shall:
   1. Provide minimum of 200 square feet.
   2. Provide air conditioning sufficient to maintain maximum of 75 degrees F interior temperature.
   3. Provide following furnishings:
      a. Conference table.
      b. Tack board.

B. Telephone Service:
   1. Contractor shall provide at least one telephone on site.
   2. Contractor shall display construction-related phone numbers at each phone.
      a. Fire emergency number.
      b. Rescue emergency number.
      c. Physician.
      d. Contractor's home office.
      e. Owner's Project Manager.
      f. Major subcontractors' home offices.

C. Security Station: Contractor shall provide a small building at the construction entrance. This building shall include the following items:
   1. Desk space and chairs for two occupants
   2. Electrical Service
   3. Air conditioning
   4. Communications device to Project Superintendent

2.06 TEMPORARY CONSTRUCTION

A. Temporary Enclosures for Weather Resistance: When building enclosure is not yet complete but interior construction may be damaged by weather, Contractor shall provide temporary enclosures adequate to keep out weather.

B. Acoustical Control Measures.
   1. Generators, dewatering pumps, and other noise generating construction equipment should have noise emission at <70dBA @ 50’
   2. All construction vehicles requiring back up alarms shall be fitted with BBS-tek White Sound backup alarms (Brigade Electronics, Inc.) or equivalent.
   3. All truck engines or other mechanical equipment to be turned off when not in use.
   4. Workers shall use communication device and avoid yelling across the site.
   5. Horns, whistles or other loud devices shall not be used to signal or summon workers.

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor shall cooperate with other contractors in location of temporary facilities.

3.02 TEMPORARY SERVICES

A. Waste Disposal Services: Contractor shall provide contracted removal service at regular intervals. Contractor shall:
   1. Remove waste at least once a week.
   2. When temperature exceeds or is expected to exceed 80 degrees F, remove at least twice a week.
   3. Provide waste collection containers for use of all contractors.

B. Dust Control Services: Contractor shall keep down dust on entire site at all times.

C. Cleaning Up: Contractor shall refer to the General Contract Conditions for cleaning up requirements; the Supplemental Contract Conditions may contain additional requirements.

3.03 TERMINATION AND REMOVAL

A. Contractor shall remove temporary facilities when no longer needed, or when use of appropriate permanent facility is approved, but not later than Substantial Completion, except when longer usage is requested by the Owner's Project Manager.

B. Contractor shall complete permanent Work delayed until removal of temporary facilities.

C. Where temporary roads are not provided in same location as permanent roads, Contractor shall restore site to original condition after removal of temporary roads. Contractor shall:
   1. Remove temporary paving.
   2. In areas to be planted, remove contaminants which inhibit growth of plants.
   3. In areas where specific soil or fill is required, remove soil and fill that does not comply.
   4. Till and re-grade as required to restore original degree of compact ion.
   5. Replace landscaping.

D. Permanent Facilities Used during Construction: Contractor shall clean and replace parts that are worn in excess of that expected during normal usage.

END OF SECTION

SECTION 016000

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section Includes:
   1. General product requirements, including:
      a. General specification requirements for all products.
      b. Product options.
      c. General requirements and procedures for maintenance materials and tools.
   2. General requirements for product documentation, including:
      a. General requirements for operation and maintenance data.
      b. General requirements for warranties.
   3. General procedures for products including:
      a. Procedures for transportation and handling.
      b. Procedures delivery and receiving.
      c. Procedures for storage.

1.02 DEFINITIONS

A. Damage: Any sort of deterioration due to weather, normal wear and tear, accident, or abuse, resulting in soiling, marring, breakage, corrosion, rotting, or impairment of function.

1.03 SUBMITTALS

A. Operation and Maintenance Data: Contractor shall submit for information only.

B. Warranties: Contractor shall submit product warranties for project record.

C. Receipts: Contractor shall submit receipts for maintenance materials and tools.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Components required to be supplied in quantity within a specification section shall be identical, interchangeable, and made by the same manufacturer.

B. No manufacturer logos shall be visible on any finished surface. Contractor shall remove any installed at no expense to the Owner.

2.02 MAINTENANCE MATERIALS AND TOOLS

A. Maintenance Materials: Contractor shall provide parts and materials for repair and maintenance; specific items required are specified in product sections.

B. Contractor shall provide products and tools which are identical to those used in the Work; if necessary to obtain identical items, Contractor shall order at the same time as products to be installed or tools to be used in the Work.

C. Contractor shall package appropriately and label to show type and quantity of contents.

D. Contractor shall deliver, handle, and store in the same manner as products to be installed.

E. Contractor shall not turn over to the Owner until date of Substantial Completion, unless otherwise approved by the Owner's Project Manager.

F. Contractor shall deliver required products to the Owner's Project Manager, and unload them at the appropriate location.

G. Contractor shall obtain receipts prior to making final payment for the products.

PART 3 - EXECUTION

3.01 PRODUCT OPTIONS

A. It is the Contractor's responsibility to select products which comply with the Contract Documents and which are compatible with one another, with existing Work, and with products selected by other contractors.
   1. Contractor shall verify that electrical characteristics of products are compatible with electrical systems; Contractor shall notify Owner's Project Manager of all discrepancies.

B. Contractor shall not use any substitute products which have not been approved in accordance with the Contract Documents.

C. Where the specification is silent on whether substitutions will be considered, substitutions will be considered.

D. Definition of Substitute Product: Any product which does not meet the requirements of the Contract Documents, whether in product characteristics, performance, quality, manufacturer or brand name, but is substantially similar in type and performance, is considered a substitute.

E. Product Options: Where products are specified using more than one method, such as description with a manufacturer list, Contractor shall use a product meeting the requirements of both specification methods.

F. Products Specified by Description: Contractor shall use any product meeting the specification.

G. Products Specified by Listing a Brand Name Product as the "Basis of Design": Contractor shall provide a product equivalent to the product specified within the limits of variation specified. Use of a product other than that specified constitutes a representation by the Contractor that it will comply with all the conditions specified for acceptance of substitutions, although formal submittal of a request for substitution is not required.

H. Products Specified by Listing Brand Name(s) Accompanied by Language Indicating that Substitutions Are Not Allowed: Contractor shall provide one of the products listed.

I. Products Specified by Listing Brand Name(s) Accompanied by Language Indicating that Substitutions Are Allowed: Contractor shall provide a product meeting the specifications and submit a substitution request for any brand-name product that is not listed.

J. Language indicating that substitutions are not allowed includes:
   1. "Provide one of the following products."
   2. "Provide products made by one of the manufacturers listed."
   3. "Provide products complying with the Contract Documents and made by one of the following."
   4. "No substitutions."
   5. Other similar language.

K. Language indicating that substitutions are allowed includes:
   1. "Substitutions will be considered."
   2. "....will be among those considered acceptable."
   3. Other similar language.

3.02 SUBSTITUTIONS AFTER AWARD OF THE CONTRACT

A. The Contractor will be notified in writing within a reasonable time; verbal acceptance will not be valid.

B. Acceptable substitutions will be added to the Contract Documents by appropriate modification.

3.03 SUBSTITUTION PROCEDURE

A. Submission of requests for substitution shall constitute a representation that the entity making the request:

1. Has investigated the proposed product and determined that it is equal to or better than the specified product.
2. Will provide the same warranty for the proposed product as for the specified product.
3. Will coordinate the installation and make other changes which may be required for the Work to be complete in all respects, including:
   a. Redesign.
   b. Additional components and capacity required by other work affected by the change.
4. Waives all claims for additional costs and time extensions which subsequently may become apparent and which are caused by the change.

B. Substitution Request Procedure: Contractor shall submit a written request with the complete data substantiating compliance of the proposed product with the requirements of the Contract Documents.
   1. Contractor shall submit requested at least 14 days prior to the date when the specified product needs to be ordered.
   2. Substitution Request Form to be used follows this section.

C. When the proposed substitution is not accepted, Contractor shall provide the product (or one of the products, as the case may be) specified.

D. Approval of a substitution does not relieve the Contractor of the need to submit a full submittal as required per Section 013000 and the applicable Section.

3.04 OPERATION AND MAINTENANCE DATA

A. Contractor shall provide operation and maintenance data as specified in individual product sections.
   1. Contractor shall provide data sufficient for operation and maintenance by Owner without further assistance from the manufacturer.

B. Data Required For Products - General:
   1. Name of manufacturer and product.
   2. Name, address, and telephone number of subcontractor or supplier.
   3. Local source of replacements.
   4. Local source of replaceable parts, supplies and service.

C. Product Data: Where product data is specified for inclusion in operation and maintenance data, Contractor shall provide manufacturer's data sheets marked to indicate specific product and product options actually installed; Contractor shall delete inapplicable data.

D. Custom Manufactured Products: Contractor shall provide all information needed for reordering.

E. Finish Materials: Contractor shall provide manufacturer's product data, color/texture designations, and manufacturer's instructions for care, cleaning, and maintenance.

F. Products Exposed to Weather and Products for Moisture Protection: Contractor shall provide manufacturer's product data, recommended inspection schedule and procedures, maintenance and repair procedures, and maintenance materials required.

G. Equipment: Contractor shall provide at least the following information:
   1. Product data giving equipment and function description, with normal operating characteristics and limiting conditions.
   2. Starting, operating, and troubleshooting procedures.
   3. Cleaning and maintenance requirements and procedures.
   4. External finish maintenance requirements.
   5. List of maintenance materials required.
   6. List of special tools required.
   7. Parts list: List all replaceable parts, with ordering data.
   8. Recommended quantity of spare parts to be maintained in storage.

H. Systems: Contractor shall provide overall function description, with diagrams, prepared especially for this project.

I. Form of Data: Contractor shall prepare data in the form of an instructional manual. Contractor shall:
   1. Arrange content logically, using section numbers and sequence of sections indicated on the table of contents of this project manual.
   2. When multiple volumes are used, arrange by related subjects and identify contents in cover title.
   3. Provide table of contents for each volume listing:
      a. Name of the project.
      b. Name, address, telephone number, and contact name of:
         1) Owner's Project Manager.
         2) Contractor.
      c. Index of products and systems included in volume.
   4. Assemble into multiple.pdf file types not exceeding 6MB per file.
      a. File name shall identify "Operation and Maintenance Instructions" and project name.
      b. All files shall be organized to print on 8 ½ x 11 inches maximum.
   5. Assemble into 3-ring binders with maximum 2-inch ring size.
      a. Hardback, cleanable plastic covers.
      b. Identify each binder with title "Operation and Maintenance Instructions" and project name.
      c. Page size 8 1/2 x 11 inches maximum.
      d. Prepare special typewritten data on minimum 20-pound paper.
      e. Provide tabbed divider for each product and system.
      f. Drawings: Bind in with other data; provide reinforced binding edge; fold larger drawings to size of pages.
         1) Do not use pockets or loose drawings.

3.05 WARRANTIES

A. Contractor shall provide warranties as specified in individual product sections, and shall warrant all labor and materials as set forth in Article 12 of the General Contract Conditions.

B. Manufacturer Warranties: Contractor shall provide manufacturer's standard product warranty running for the manufacturer's standard term, unless otherwise indicated.
   1. Contractor shall submit copies of all manufacturer warranties which extend beyond the end of the contract correction period.

C. Contractor shall provide 2 notarized copies of each executed warranty.

D. Contractor shall provide actual date of commencement on each warranty.

3.06 TRANSPORTATION AND HANDLING

A. Contractor shall:
   1. Require suppliers to package finished products in a manner which will protect them from damage during shipping, handling, and storage.
   2. Transport products by methods which avoid damage.
   3. Deliver in dry, undamaged condition in manufacturer's unopened packaging.
   4. Provide equipment and personnel adequate to handle products by methods which prevent damage.
   5. Provide additional projection during handling where necessary to prevent damage to products and packaging.
   6. Lift large and heavy components at designated lift points only.

3.07 DELIVERY AND RECEIVING

A. Contractor shall:
   1. Arrange deliveries of products to allow time for inspection prior to installation.

2. Coordinate delivery to avoid conflict with the work and to take into account both the conditions at the site and the availability of personnel, handling equipment, and storage space.
3. Clearly mark partial deliveries to identify contents, to permit easy accumulation of entire delivery, and to facilitate assembly.
4. Promptly inspect shipments and remedy damage, incorrect quantity, incompleteness, improper or illegible labeling, and noncompliance with requirements of Contract Documents and approved submittals.

3.08 STORAGE

A. No indoor storage areas are available on site.

B. General Storage Procedures. Contractor shall:
1. Store products immediately on delivery.
2. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible.
3. Store in a manner to prevent damage to the stored products and to the work.
4. Store moisture-sensitive products in weathertight enclosures.
5. Store indoors if necessary to keep temperature and humidity within ranges required by manufacturer.
6. Store unpacked and loose products on shelves, in bins, or in neat groups of like items.
7. Arrange storage to provide access for inspection and inventory.
8. Periodically inspect and remedy damage and noncompliance with required conditions.

C. Loose Granular Materials: Contractor shall store on solid surfaces in well-drained area; Contractor shall prevent mixing with foreign materials.

D. Exterior Storage: Contractor shall:
1. Cover products subject to weather damage with impervious sheet covering and provide ventilation to avoid condensation.
2. Provide surface drainage to prevent runoff or ponded water from damaging stored products.
3. Prevent damage and contamination from refuse and chemically injurious materials and liquids. Store fabricated products on substantial platforms, blocking or skids above the ground, sloped to drain.

END OF SECTION

SUBSTITUTION REQUEST FORM DATE: _____

TO: SEAWORLD PARKS & ENTERTAINMENT, INC.

ATTENTION: _____

PROJECT: _____

We hereby submit for your consideration the following product as a substitute for the specified product for the above project:

Section No. Paragraph Specified Product

_____ _____ _____

Proposed Substitution: _____

_____

Product Data:

Attach complete technical data for proposed substitution.

Include complete information on changes to Contract Documents which proposed substitution will require for its proper installation.

Samples:

[ ] Attached [ ] Will be furnished upon request

Does the substitution affect dimensions shown on drawings?

[ ] No [ ] Yes (explain on attachment)

Effects of proposed substitution on other trades:

_____

_____

Differences between proposed substitution and specified product:

_____

_____

Manufacturer's warranties of the proposed and specified products are:

[ ] Same [ ] Different (explain on attachment)

Maintenance services and spare parts are available for proposed product from:

_____

_____

Previous installations where proposed product may be seen:

Project: _____ Project: _____

Owner: _____ Owner: _____

Architect: _____ Architect: _____

Date Installed: _____ Date Installed: _____

Cost savings to be realized by Owner, if proposed substitution is accepted:

_____

Change to Contract Time, if proposed substitution is accepted:

[ ] No Change [ ] Add ____ days [ ] Deduct ____ days

By submitting this substitution request, Contractor represents that he has read and agrees to the provisions of Section 016000.

Submitted by Contractor:

_____
Signature

_____
Firm

For Use By Owner:

Based on the information supplied by the Contractor, the Owner's Project Manager has reviewed the proposed substitution on the basis of design concept of the Work and conformance with information given in Contract Documents.

[ ] Accepted [ ] Accepted as Noted [ ] Rejected

[ ] Submit Additional Information: _____

_____

By: _____ Date: _____

SECTION 017000

CONSTRUCTION PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section Includes:
   1. General construction and installation procedures.
   2. Cutting procedures.
   3. Patching procedures.
   4. Correction of defective work.
   5. Cleaning during construction.
   6. Facility startup.
   7. Project completion procedures.
   8. Final cleaning.
   9. EPA-NPDES, Construction Pollution Prevention Plan.

B. Related Sections:
   1. Cleaning requirements for specific products and systems: Applicable product sections in Divisions 2 - 41.
   2. General product installation requirements: Elsewhere in Division 01.
   3. Sequence of the work: Elsewhere in Division 01.
   4. Testing, adjusting, and balancing of mechanical systems: Division 23.
   5. Waste removal services: Elsewhere in Division 01.

1.02 DEFINITIONS

A. Concealed Spaces: Spaces which are not accessible after completion of construction.

B. Cutting: Removal of material by cutting, sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation.

C. Damage: Any sort of deterioration whether due to weather, normal wear and tear, accident, or abuse, resulting in soiling, marring, breakage, corrosion, rotting, or impairment of function.

D. Debris: Rubbish, waste materials, litter, volatile wastes, and similar materials, with the exception of surplus materials which are to become the property of the Owner.

E. Operational Elements: Equipment, moving parts, electrical conductors, sound and vibration control materials, waterproofing, vapor retarders, piping, ducts, tanks, and other similar materials and components which convey or retard the passage of liquids, gases, heat, light, persons, animals, or insects or which perform a similar function; not including structural elements.

F. Patching: Restoration to completed condition by patching, repairing, finishing, filling, closing up, and similar operations.

G. Replacement: Replacement the entire element, surface, or product.

1.03 SUBMITTALS

A. Proposals for Cutting and Patching: Contractor to submit request sufficiently in advance of the time the work is to be performed to obtain approval; include:
   1. Description of the nature of the work and how it is to be performed, including reasons why cutting cannot be avoided.
   2. Description of results expected, including impact on safety and on structural, operational, and visual qualities.
   3. If utilities are affected, describe the changes required and be specific as to how long service will be cut off.

4. If cutting of structural work results in the need for additional reinforcement, provide details and engineering calculations to show how that reinforcement satisfies the original structural requirements.

B. Startup Reports:
   1. Include a statement that the item has been installed properly and is functioning correctly.
   2. Include the following information:
      a. Item started up.
      b. Date of startup operation.
      c. Entity performing startup.
      d. Applicable specification section.
      e. Results of startup.
      f. Signature of person performing startup.

C. Demonstration Reports
   1. Include the following information:
      a. Description of equipment or system demonstrated, cross-referenced to the Contract Documents.
      b. Date of demonstration.
      c. Name and title of person performing demonstration.
      d. Name, title and signature of person observing demonstration.

D. Field Correction Requests: Submit immediately upon discovery of deviation required; include a detailed description of the problem, recommended changes, and reasons it is not possible to comply with the Contract Documents.

E. Provide a certificate from surveyor stating that the construction has been placed in the locations and at the elevations required by the Contract Documents. Any deviations shall be noted on the Project Record Drawings, see Section 018000.

1.04 QUALITY ASSURANCE

A. Cleaning: Perform cleaning in accordance with the recommendations of the manufacturer of fabricator of the product or system. Use only cleaning materials and tools which are specifically recommended, which are not hazardous to health or property, and which will not damage finishes.

1.05 PROJECT CONDITIONS

A. Take precautions to prevent fires and to facilitate fire-fighting operations.
   1. Keep flammable materials in non-combustible containers; store away from potential fire sources; remove flammable waste regularly.
   2. Keep temporary and permanent fire-fighting facilities readily accessible; keep fire-fighting routes open.
   3. Do not allow smoking in areas where highly combustible or explosive materials are present.
   4. Carefully supervise the operation of potential fire sources, including heating units.
   5. Conduct welding operations in manner to prevent fire; comply with local regulations.

B. Take precautions to prevent accidents due to physical hazards:
   1. Provide barricades, warning lights, or signs as required to inform personnel and the public of the hazard being protected against.
   2. Safety barricades: Comply with regulations.
   3. Provide temporary walkways where walking surfaces are hazardous.
   4. Notify the Owner's Project Manager before beginning work that involves hazardous operations, including use of explosives.

C. Take care to prevent pollution of air, water, and soil.
   1. Comply with environmental protection regulations.
   2. Limit effluent and rainwater runoff into waterways as required by regulations.

3. Do not dump contaminants in areas that will result in contamination of waterways.

D. Minimize discharge of effluent and rainwater runoff into sewers.
   1. Control sediment discharge into sewers; filter out construction debris, soil, and contaminants.
   2. Comply with regulations and orders of public utilities regarding use of sewers.
   3. Where disposal of effluent or rainwater by means of sewers is not lawful or is not possibly, provide alternative methods of disposal.

E. Prevent erosion due to rainwater runoff.

F. Control windblown dust; prevent nuisance to Owner's personnel, animals and visitors.

G. Prevent flooding of excavations, below-grade construction, and adjacent areas due to rainwater runoff.

H. Do not use tools or equipment which produce harmful levels of noise.
   1. Minimize the use of noise-making tools and equipment during hours that adjacent areas are in use.
   2. Coordinate hours of use of noise making tools and equipment adjacent to animal areas with the Owner’s Project Manager.

I. Keep the site and adjacent public ways free of hazardous and unsanitary conditions and public nuisances.

J. Control rodents and other pests.

K. Keep adjacent areas free of debris due to this work.

L. Provide adequate traffic control by means of signs, signals, and flagmen, as necessary.

M. Provide temporary means of draining roofs where required.

N. Conduct construction operations so that no part of the work is subjected to damaging operations or influences which are in excess of those to be expected during normal occupancy conditions.

O. Conduct construction operations so that waste of power, water, and fuel is avoided.

P. Provide temporary supports as required to prevent movement and structural failure.

Q. Install products only during environmental conditions which will ensure the best possible results.

1.06 SEQUENCING AND SCHEDULING

A. Install products only at the time and in the sequence which will ensure the best possible results.

B. Coordinate required administrative activities with related construction activities.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Patching Materials: Identical to the materials of the work to be cut, unless indicated as specific materials specified in other sections.

PART 3 - EXECUTION

3.01 GENERAL EXAMINATION REQUIREMENTS

A. Prior to performing work, examine the applicable substrates and the conditions under which the work is to be performed.

B. If unsafe or otherwise unsatisfactory conditions are encountered, take corrective action before proceeding.

C. Conditions which could have been discovered by examination will not be allowed as cause for claims for extra work.
   1. The existence and location of construction indicated as existing on the drawings are not guaranteed.
   2. In particular, verify the following:
      a. Underground utilities.
      b. Other underground construction.
      c. Location and invert elevation of points of connection to piped utilities.

D. Verify that utility requirements of operating equipment are compatible with building utilities.

E. Verify space requirements of items which are shown diagrammatically on the drawings.

3.02 GENERAL PREPARATION REQUIREMENTS

A. Take field measurements as required to fit the work properly.

B. Recheck measurements prior to installing each product.

3.03 GENERAL INSTALLATION PROCEDURES

A. Accurately locate the work and components of the Work; make vertical work plumb; make horizontal work level.

B. See sections describing specific parts of the Work for additional requirements.

C. Where space is limited, install components to maximize space available for maintenance and to maximize ease of removal for replacement.

D. In finished areas, conceal pipes, ducts, and wiring within the construction, unless otherwise indicated.

E. Coordinate exact locations of fixtures and outlets with finish elements.

F. Install Work in such a manner and sequence as to preclude, if possible, or at least to minimize cutting and patching.
   1. Do not cut any operational elements.

G. Install all Work to ensure proper drainage.

3.04 CLEANING AND PROTECTION

A. Contractor shall remove debris from concealed spaces prior to enclosing the space.

B. Keep the site and the Work free of waste materials and debris.
   1. Keep hazardous and unsanitary materials in containers separate from other waste.

C. Clean areas in which Work is to be done to level of cleanliness necessary for proper execution of that Work.
   1. Where dust would impair execution of Work, broom- and vacuum-clean the entire interior area and keep clean.

D. Keep installed Work clean, and clean again when soiled by other operations.
   1. Provide periodic cleaning as required to prevent damage due to soiling.
   2. Remove liquid spills promptly.

E. Protect installed Work from soiling and damage.
   1. Provide protective coverings as required.
   2. Provide protective coverings for Work which may be damaged by subsequent operations.
   3. Where heavy abuse is expected, use minimum of plywood for protection.
   4. Maintain protective coverings until substantial completion.

3.05 CUTTING AND PATCHING PROCEDURES

A. Use specified cutting and patching procedures when cutting or patching is required for any of the following activities:
   1. Fitting the parts of the Work together.
   2. Repairing existing Work to remain.
   3. Installing ill-timed Work.
   4. Removing and replacing defective and nonconforming Work.
   5. Removing samples of Work for testing.
   6. Making openings in elements of Work for penetrations, such as for piping, conduit, duct, and the like.
   7. Uncovering Work for observation.
   8. Repairing damage.

B. At no time shall cutting and patching be considered an acceptable alternate to properly sequenced work. Cutting and patching shall be avoided wherever possible.

C. Perform cutting and patching at earliest time feasible, unless otherwise indicated or directed by the Owner's Project Manager.

D. Use procedures specified in applicable product sections as well as those specified in this section:
   1. Use procedures recommended by original installer, when such information is available.
   2. Where required, obtain approval of procedures by the Owner's Project Manager.
   3. Cut using methods that are least likely to damage adjacent Work and Work to remain and which will provide proper surfaces for patching.
   4. Make cuts neatly with minimum disturbance of adjacent Work.
      a. Use appropriate tools intended for sawing or grinding and not for chopping or hammering.
      b. Do not use pneumatic tools without prior approval.
   5. Where installation of similar new Work is included, perform patching in manner specified for installation of new Work.
   6. Where new Work is inserted into or through the Work that is cut, fit the patched work tightly to the new Work.
   7. Patch with seams which are durable and as invisible as possible.
   8. Repair substrate prior to patching finish.

E. Employ skilled workers to perform cutting and patching work.
   1. Use the original installer of the work to perform cutting and patching of the following:
      a. Any products so indicated in the applicable product session.

F. Work Exposed to View: Do not cut or patch in a manner that would result in a lessening of the building's aesthetic value, as determined by the Owner's Project Manager.
   1. Generally, cut from exposed side into concealed spaces to avoid unnecessary damage to finish.
   2. Do not cut and patch in a manner that would result in substantial visual evidence of cut and patch work.
   3. Restore exposed patched finishes in a manner which eliminates evidence of patching and refinishing.
      a. For continuous surfaces, extend refinish to nearest intersection, with a neat transition to adjacent surfaces.
      b. For assemblies: Refinish entire unit.
      c. Painted piping, conduit, and duct: Clean and repaint.
   4. Remove and replace work which is patched in a visually unacceptable manner.

G. Structural Elements: Maintain structural capacity; do not increase deflection under design load; provide reinforcing where required.
   1. See structural sections for additional requirements.

2. Before cutting any structural member, obtain approval of the proposed method from the Structural engineer-of-record and the Owner's Project Manager.

H. Existing Conditions:
   1. Patch existing work to match adjacent existing work to remain.
   2. Where specified procedures for similar new work are applicable, use those procedures for cutting and patching existing construction.
   3. Take precautions to avoid damage to unanticipated utilities and structural elements. If such elements are encountered, report nature and extent to the Owner's Project Manager and request instructions as to how to proceed.

I. Concealed Work: Uncover the concealed work, cut and patch, and patch the covering work.

J. Concrete and Masonry: Use saws or drills which produce a neat cut; remove in small sections.

K. Protect the part of the project which is exposed during cutting and patching operations from adverse weather.

3.06 INSTALLATION OF COMPONENTS

A. Install all products in accordance with manufacturer's instructions and recommendations, whether conveyed in writing or not.

B. Mounting Heights: Where mounting heights are not indicated, install components at mounting normally encountered for similar components.
   1. Obtain instructions from the Owner's Project Manager for uncertain mounting heights.

C. Separate incompatible materials with suitable materials or spacing.
   1. Prevent cathodic corrosion.

D. Joints in Exposed Work:
   1. Make joints of uniform widths.
   2. Where joint locations are not indicated, arrange joints for the best visual effect.
      a. When in doubt, obtain the instructions from the Owner's Project Manager.

E. After installation, adjust operating components to proper operation.

3.07 PROCEDURES FOR CORRECTION OF WORK

A. The following must be replaced (repair is not acceptable):
   1. Damaged surfaces exposed to view which cannot be repaired without visible evidence of repair.
   2. Components which cannot be repaired to proper operating condition.
   3. Scratched transparent materials.

B. Repair or Replace:
   1. Components which do not operate properly.
   2. Surfaces exposed to view which cannot be cleaned to original condition.
   3. Permanent facilities used during construction.
   4. Other defective Work.

C. Acceptable Repair Methods:
   1. Replacing parts.
   2. Refinishing.
   3. Touching up with matching materials.
   4. Proper adjustment of equipment.

D. When it is necessary to deviate from the Contract Documents in order to accomplish corrective action, submit a field correction request.

E. Restore permanent facilities used during construction to specified condition.

3.08 FACILITY STARTUP

A. Put each item of equipment and each system into full, satisfactory operation.

B. Prior to Startup:
   1. Verify that equipment and systems are complete, correctly connected to utilities, and tested.
      a. Comply with requirements of manufacturer.
   2. Inspect and test as required to ensure that Work is installed as specified and to determine suitability for energizing.
   3. Change over from temporary to permanent utility sources.
   4. Re-adjust and lubricate operating components as required to ensure smooth and unhindered operation.
      a. Check drive rotations, belt tension, control sequences, and other features which might cause damage if not properly adjusted.
   5. When specified or when required by manufacturer, have manufacturer's representative prepare for startup or supervise such preparation.

C. Execute startup under supervision of responsible personnel in accordance with the manufacturer's instructions.
   1. When specified or when required by manufacturer, have manufacturer's representative perform startup.
   2. Submit a written report of startup operation.

D. After startup, adjust equipment and systems as required for proper operation.
   1. Where specified, perform tests or inspections to determine status of operation.

E. Demonstrate the operation and maintenance of equipment and systems to personnel designated by the Owner’s Project Manager, prior to substantial completion.
   1. Have final operating and maintenance data available during demonstration.

F. For equipment and systems which have different operation at different seasons, demonstrate operation during subsequent seasons until fully demonstrated.

3.09 FINAL CLEANING

A. Remove materials and equipment which are not part of the Work and all debris from the site prior to substantial completion.
   1. Remove all surplus materials which are to remain property of the Contractor; obtain the instructions from the Owner's Project Manager as to disposition of surplus material remaining on site and deliver, store, or dispose of as directed.
   2. Remove tools and construction equipment.
   3. Remove protective coverings.
   4. Remove temporary facilities.

B. Dispose of debris in a lawful manner.
   1. Do not dispose of volatile wastes in storm or sanitary drains.

C. Perform final cleaning prior to requesting inspection for Substantial Completion.
   1. Clean as specified for periodic cleaning.

D. Clean entire project site and grounds.
   1. Clean up landscaped areas.
   2. Broom clean paved areas.
   3. Rake smooth all exposed earth surfaces.
   4. Remove snow and ice from building and site accesses.

E. Leave the project clean and ready for occupancy.

3.10 PROJECT COMPLETION PROCEDURES

A. Complete the Work, prior to Substantial Completion, as required to obtain consent to occupancy from the governing authorities.

B. Arrange for final inspection by governing authorities to be accomplished prior to Substantial Completion.
   1. Obtain certificate of occupancy.

C. Upon request of the Contractor, the Owner's Project Manager will perform inspection for Substantial Completion.
   1. No partial certificates of Substantial Completion will be issued.

3.11 EPA-NPDES CONSTRUCTION POLLUTION PREVENTION PLAN

A. All site construction activities shall be conducted in such a manner as to conform to the guidelines included in the Pollution Prevention Plan for this Project.

B. The Contractor and the subcontractors involved in the site shall become familiar with the requirements of the Plan. Refer to Owner provided Pollution Prevention Plan.

C. The Contract Drawings provides graphical information complementing the written part of the Pollution Prevention Plan.

END OF SECTION

SECTION 017060

EQUIPMENT BY OTHERS

PART 1 - GENERAL

1.01 SUMMARY

A. Equipment furnished in other sections of this specification or by others, including separate contractors and by the Owner, that require service from a system provided by Contractor shall be roughed in by Contractor and final connection shall be by Contractor. Final connections shall include traps, valves, tailpieces, line strainers, pressure reducing valves, and vacuum breakers, and incidentals required to make equipment functional.

1.02 ITEMS PURCHASED BY OWNER AND INSTALLED BY CONTRACTOR

A. Items associated with the Ride
   1. Ride structure
   2. Ride anchor bolts
   3. Ride control units
   4. Ride electric and pneumatic components installed on the ride structure
   5. Ride vehicles
   6. Actuating gates
   7. Sensors at gates and operator positions

B. Items associated with Ride Photo
   1. Computer hardware
   2. Cameras and associated strobe / flash lights
   3. Monitors
   4. Ride photo sales kiosks

C. Items associated with Guest Lockers
   1. Lockers
   2. Locker sales kiosks

D. Furnishings
   1. Trash receptacles
   2. Recycle receptacles

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EQUIPMENT COORDINATION REQUIREMENTS

A. Contractor is responsible for the coordination of all utilities to support all equipment furnished by others, including size/capacity/rating of such. The Owner/Equipment Consultant will furnish to the Contractor all vendor-produced installation and utility requirements and final equipment locations for utility rough-in. Contractor is responsible to coordinate utility requirements and locations on a room by room basis. Contractor shall notify the Owner’s Project Manager immediately of any discrepancies in utility requirements as provided for in the Contract Documents. Contractor shall inform the Architect and the Owner’s Project Manager of the latest date final equipment locations must be received without impacting project cost or schedule.

B. Contractor's base price shall include rough-in and connection of equipment utilities at any location within the room shown on the contract documents at the time of bid submittal. Relocation of any piece of equipment and associated utilities to any position within the original room prior to rough-in shall be included in the base contract amount.

C. Contractor shall incorporate any changes in equipment location and associated utility rough-ins into the Record Documents to be presented to the Architect and the Owner's Project Manager at the completion of construction.

3.02 DELIVERY AND STORAGE

A. Unless noted otherwise, Contractor shall off load and store all equipment by others. All equipment shall be stored as recommended by the manufacture, as directed within the Contract documents, or as necessary to protect the equipment from physical damage and weather.

B. Immediately upon receipt all equipment shall be inspected by Owner's Project Manager and the Contractor. Any apparent damage shall fully documented. Contractor assumes all liability and responsibility for any damage which occurs after receipt of equipment. Any damages must be repaired to the satisfaction of the Owner's Project Manager and in such a manner that maintains the fully manufacturer's warranty, and in no way compromises the quality and appearance of the equipment.

3.03 INSTALLATION

A. Contractor shall install all incidental items associated with his systems and as recommended by the respective manufacturers. All final connections of waste, water, air, gas, etc., shall be installed by Contractor as directed by the equipment manufacturer. Incidental items such as adapters and unions required to make the final connection shall be provided by Contractor.

B. If disassembly and reassembly of the equipment is necessary for installation, this shall be done in accordance with the manufactures instructions.

C. Contractor shall make all final connections to equipment as required to provide a fully functional system, as recommended by the respective manufacturers. All final connections to equipment shall be installed as directed by the equipment manufacturer. Incidental items required to make the final connection shall be provided by this contractor.

D. Contractor shall review any needed changes to the equipment placement with Owner's Project Manager prior to finalizing the installation. Any changes necessary to maintain the original design intent due to lack of coordination by Contractor as required herein shall be done at no cost to Owner.

3.04 TESTING AND BALANCING

A. The requirements of Section 230593 - Testing, Adjusting and Balancing shall apply to Owner furnished equipment.

B. Provide testing of equipment furnished by others as described in associated equipment and/or piping sections and as recommended by the Manufacturer.

3.05 GUARANTEE

A. Contractor shall furnish a written one year guarantee on all work performed to install equipment.

B. Unless directed otherwise, upon completion of installation Contractor shall have equipment inspected by manufacturer and certified in compliance with their requirements and that all warranties remain valid.

END OF SECTION

SECTION 017100

CONSTRUCTION TOLERANCES FOR DIMENSIONS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes general procedural requirements governing allowable construction tolerances for dimensions.
   1. Dimensional tolerances stated in the technical sections of Divisions 2 through 33 shall become part of the Contract, regardless if they exceed or keep under standard construction industry tolerances.
   2. Dimensional tolerances not included in the sections shall be subject to standard industry recommendations, unless noted otherwise in the contract documents.
   3. Manufactured products:
      a. Factory manufactured and/or shop fabricated elements for the project shall remain within ¼" of all published sizes in all directions.

1.02 SUBMITTALS

A. Certificates: Submit certificate signed by Contractor indicating that all completed sizes, locations, and elevations comply with the contract documents, and are within the specified dimensional tolerances.
   1. Submit certification prior to request for Substantial completion.

1.03 QUALITY ASSURANCE

A. It is the intention of the contract that all work be completed at the dimensions shown in the contract documents. Dimensional tolerances are included to demonstrate the maximum deviations that will be allowed.
   1. It shall be the Contractor's responsibility to ensure that all work fits and functions as required, including adjustments as needed, due to dimensions that extend into the allowed tolerances.
   2. Installed work exceeding the limits of the allowed tolerances is subject to removal and replacement as directed by the Owner's Project Manager, at no cost to the Owner.

B. Contractor shall perform an investigation of the entire project to finally determine that all elements of the project are constructed within the tolerances allowed by the contract documents.

C. Contractor shall not knowingly install work that does not comply with allowed tolerances.

D. Contractor shall examine, prior to execution, all documents, and advise all subcontractors in writing of their obligations to comply with construction tolerances as specified.
   1. Refer to specifications section for "Accessibility for Persons with Disabilities" for surveys and certifications required for accessibility.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other elements affecting the Work.
   1. Before construction, verify the locations and points of connection of utility services.
   2. Prior to starting work, contractor shall determine if any existing conditions will prevent compliance with the dimensions of the Contract Documents.
      a. Advise the Owner's Project Manager immediately if any such conditions exist.

b. Do not proceed with work until any needed adjustments to the contract are accomplished.
    1) Proceeding with work indicates acceptance of conditions.
3. Refer to Section 017000 - Construction Procedures for more examination specifications.

3.02 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction, including work that is not within specified construction tolerances. Restore damaged substrates and finishes. Comply with requirements in Section 017000 - 3.05 - Cutting and Patching Procedures.
    1. Repairing includes, in addition to correcting dimensions that are not compliant with allowed tolerance, replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment so repair work blends in and matches the surrounding work.

END OF SECTION

SECTION 018000

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section Includes:
   1. Project record documents consisting of:
      a. Record drawings.
      b. Record project manual (specifications).
      c. Record submittals:
         1) Shop drawings.
         2) Coordination drawings.
         3) Product data.
         4) Samples.

1.02 CONTRACT CLOSEOUT SUBMITTALS

A. At completion of project, Contractor shall deliver record documents to Owner's Project Manager.
   1. Record Drawings: Provide physical documents at full size bound into manageable sets.
      a. Contractor to provide Owner's Project Manager two (2) DVD copies of record drawings.
   2. Record Project Manual (Specifications): Provide 3-ring binder(s).
      a. Contractor to provide Owner's Project Manager two (2) DVD copies of Project Manual.
   3. Record submittals: Refer to Section 013000.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 MAINTENANCE OF PROJECT RECORD DOCUMENTS

A. Contractor shall maintain at job site, one printed full-size copy of each of the following as record documents.
   1. Contract Drawings including Addenda, Revisions, and Field Modifications. (Blueline prints.)
   2. Project Manual including Addenda, Revisions, and Field Modifications
   3. Approved shop drawings and samples.
   4. Modifications, Revision Orders, Directives and other written amendments to the Contract.
   5. Field Test records.
   6. Safety Log.

B. Contractor shall observe the following guidelines for maintenance of record documents:
   1. Store record documents in temporary field office apart from documents used for construction purposes.
   2. Provide files and racks for storage of record documents.
   3. Maintain record documents in clean, dry, and legible condition.
   4. Do not use record documents for construction purposes.
   5. Make record documents available at all times for inspections by Owner's Project Manager and other authorized users.

3.02 MARKING DEVICES

A. Contractor shall provide ball-point colored pens for marking.

3.03 RECORDING

A. Contractor shall label each record document "Project Record" in 2 inch high printed letters.

B. Contractor shall keep record documents current.

C. Contractor shall not permanently cover or conceal any work until required information has been recorded.

D. Record Contract Drawings: Contractor shall legibly mark-up drawings to record:
   1. Depths of various elements of foundations in relation to survey datum.
   2. Horizontal and vertical location of all underground utilities, process piping and appurtenances referenced to permanent surface improvements.
   3. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.
   4. Revisions to electrical circuits.
   5. Actual equipment locations.
   6. Sizes and routings of ducts.
   7. Field changes of dimension and detail.
   8. Changes made by Revision Order, Directive and other modifications.
   9. Details not in original contract drawings.
   10. New information which may be useful to the Owner, but which was not show in either the Contract Documents or submittals.

E. Per the Owner - Contractor Agreement, if directed by the Owner's Project Manager, the Contractor shall deliver the Record Documents to Owner's Project Manager for incorporation into the Original Drawings. The Contractor will then review the revisions and return the final drawings to the Owner's Project Manager.

F. Contractor shall record Addenda, Revisions and Field Modifications to the Specifications and Drawings. Contractor shall legibly mark-up each Section or Sheet to record:
   1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
   2. Changes made by Revision Order, Directive and other modification.
   3. Other matters not originally specified.

G. Shop Drawings and Samples. Contractor shall:
   1. Maintain as record documents.
   2. Legibly annotate shop drawings and samples to record changes made after approval.

H. Record Coordination Drawings:
   1. Contractor shall record the types of information required for all record documents.

3.04 AUDIT

A. Project record documents shall be available for review monthly by the Owner's Project Manager, who may use the current completeness of the record documents in evaluating the monthly progress payment request.

END OF SECTION

SECTION 024100

DEMOLITION

PART 1 - GENERAL

1.01 SUMMARY

A. The work of the demolition includes, but is not limited to, saw cutting, breaking, removing, loading, hauling and disposing of the following items: AC paving, chain link fence, existing above ground and underground utilities, trees, and other miscellaneous materials necessary to be removed to construct the Project as specified in this Section – DEMOLITION, and Section 311100 – CLEARING AND GRUBBING.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 024113 – SITE CLEARING

B. Section 024119 – SELECTIVE DEMOLITION

1.03 REFERENCE STANDARDS

A. Standard Specifications
   1. Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including the Regional Supplement.
   2. State of California, Department of Transportation, Standard Specifications, 2018.
   3. City of San Diego Standard Special Provisions (to the Green Book), January 2018.

B. Standard Drawings
   1. San Diego Regional Standard Drawings (2012).
   2. Design and Construction Standards of the City of San Diego (2002).

C. American National Standards Institute (ANSI)
   1. ANSI A10.6 Safety Requirements for Demolition Operations

1.04 REGULATORY REQUIREMENTS

A. In addition to the foregoing referenced standards, the regulatory requirements that govern the work of this Section include the following governing codes:
   1. California Code of Regulations (CCR), Title 8, Chapter 4, Subchapter 4 – Construction Safety Orders.
   2. California Code of Regulations (CCR), Title 24, Part 2, California Building Code, Chapter 33, “Site Work, Demolition and Construction.”

1.05 PERMITS

A. The Contractor shall obtain all special permits and licenses and give all notices required for performance and completion of the demolition and removal work, hauling, and disposal of debris.

1.06 SUBMITTALS

A. Permits: Submit copies of demolition, hauling, and debris disposal permits and notices for record purposes. Include description of proposed haul routes.

1.07 SITE CONDITIONS

A. Protection of Persons and Property:
   1. Erect and maintain temporary bracing, shoring, lights, barricades, signs, and other measures as necessary to protect the public, workers, and adjoining property from damage from demolition work, all in accordance with applicable codes and regulations.
   2. Open depressions and excavations occurring as part of this work shall be barricaded and

posted with warning lights when accessible through adjacent property or through public access. Operate warning lights during hours from dusk to dawn each day and as otherwise required.

3. Protect utilities, pavements, and facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by demolition operations.

B. Protection of Utilities:
   1. Protect active sewer, water, electric, and other utilities; and drainage indicated or, when not indicated, found or otherwise made known to the Contractor before or during demolition work. If utility is damaged, immediately notify the utility owner for corrective action.
   2. Arrange with and perform work required by utility companies and municipal departments for discontinuance or interruption of utility services due to demolition work.

C. Dust Abatement:
   1. Provide continuous noise and dust abatement as required to prevent disturbance and nuisance to the public and workers and to the occupants of adjacent premises and surrounding areas. Dampen or cover areas affected by demolition operations as necessary to prevent dust nuisance.
   2. When a certain level of noise is unavoidable because of the nature of the work or equipment involved, and such noise is objectionable to the occupants of adjacent premises, make arrangements with the jurisdictional authorities to perform such work or operate such equipment at the most appropriate time periods of the day.

D. Unknown Conditions:
   1. The Contract Drawings and related documents may not represent all surface conditions at the site and adjoining areas. The known surface conditions are as indicated, and shall be compared with actual conditions before commencement of work.
   2. Existing utilities and drainage systems below grade are located from existing documents and from surface facilities such as manholes, valve boxes, area drains, and other such surface fixtures.
   3. If existing active services encountered are not indicated or otherwise made known to the Contractor and interfere with the permanent facilities under construction, notify the Engineer in writing, requesting instructions on their disposition. Take immediate steps to ensure that the service provided is not interrupted, and do not proceed with the work until written instructions are received from the Engineer.
   4. Thickness of existing pavements are from previous construction documents, and do not imply the actual depth or thickness of the total pavement or base material, where it occurs. Remove pavement of whatever thickness as required.

PART 2 - PRODUCTS

2.01 MATERIALS, EQUIPMENT, AND FACILITIES

A. The Contractor shall furnish all material, tools, equipment, devices, appurtenances, facilities, and services as required for performing the demolition and removal work.

B. Materials used for backfill shall conform to the requirements for fill material of Section 312200 – GRADING.

PART 3 - EXECUTION

3.01 PRESERVATION OF REFERENCE MARKERS

A. Record the locations and designation of survey markers and monuments prior to their removal. Provide three reference points for each survey marker and monument moved, established by a licensed civil engineer or land surveyor currently registered in the State of California.

B. Store removed markers and monuments during demolition work, and replace them upon completion of the work. Re-establish survey markers and monuments in conformance with the

recorded reference points. Forward to the Engineer a letter verifying re-establishment of survey markers and monuments, signed by a licensed civil engineer or land surveyor currently registered in the State of California.

3.02 DEMOLITION

A. Perform demolition in accordance with the approved Demolition Plan. Perform demolition work in accordance with ANSI A10.6 and the California Code of Regulations, Title 8 and Title 24, as applicable.

B. Cap and plug pipe and other conduits that are abandoned in place due to demolition, with approved type caps and plugs as required by the utility owners.

C. Backfill and compact depressions caused by excavations, demolition, and removal in accordance with applicable requirements of Section 312200 – GRADING.

D. Coordinate as required with the work of Section 024113 – SITE CLEARING.

E. Burying of trash and debris on the site will not be permitted. Burning of trash and debris at the site will not be permitted.

3.03 REMOVAL

A. Sawcut, break, and remove existing AC paving, and site improvements, as shown on the plans and as necessary for construction of the Project.

B. Remove utility lines to limits shown on the plans and backfill as required with work of Section 312200 – GRADING.

C. Reserved – Not used.

3.04 CLEANUP

A. Provide a clean and orderly site at all times.

END OF SECTION

SECTION 024113

SITE CLEARING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Provide all labor, material, tools and equipment for site clearing, including clearing and grubbing, removal of existing trees, debris and pavement, walks and curbs.

B. The engineer makes no representation that the survey information is complete or that it addresses every site condition, which may be significant to the proposed work. The provision of the survey information by the contract documents does not relieve the contractor of the responsibility to carefully examine the site and to take into account any conditions or variance with or in addition to the conditions shown on the survey. The contractor shall notify the owner prior to clearing, grubbing, grading or other ground disturbance if any such conditions or variance exist.

1.02 REFERENCES STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
   1. Standard Specifications
      a. American National Standards Institute (ANSI), ANSI A10.6, Latest Demolition Operations-Safety Requirements.
      b. Standard Specifications for Public Works Construction (Latest Edition), including the Latest Regional and Latest City of San Diego Supplemental Amendments.
      c. State of California Department of Transportation (Caltrans) Standard Specifications, Latest Edition.
      d. State of California Department of Transportation (Caltrans) "Manual of Traffic Control for Construction and Maintenance Works Zones" Latest Edition.
   2. Standard Drawings
      a. San Diego Regional Standard Drawings, as last amended, shall apply to the work to the extent referenced on the drawings.
      b. City of San Diego Standard Drawings, as last amended, shall apply to the work to the extent referenced on the drawings.
      c. State of California Department of Transportation (Caltrans) Standard Plans, Latest Edition.
      d. Standard Plans for Public Works Construction, as last amended, prepared by Southern California Chapter of the American Public Works Association.

C. Geotechnical Report: A Geotechnical Report has been prepared for this project and is available for the Contractor's review. The Geotechnical Report is entitled PRELIMINARY GEOTECHNICAL INVESTIGATION, SEAWORLD 2021 PROJECT, SEAWORLD ENTERTAINMENT PARK, 500 SEA WORLD DRIVE, SAN DIEGO, CALIFORNIA PREPARED BY CHRISTIAN WHEELER ENGINEERING, DATED SEPTEMBER 20, 2019, (THEIR PROJECT NO. CWE-2190160.01). The Geotechnical Report is believed accurate, however, neither the information contained therein, nor conditions indicated to exist at the test hole locations or other site locations is guaranteed to prevail throughout the job site.

1.03 RELATED SECTIONS

A. Section 015000 - Temporary Facilities and Services

B. Section 024119 - Selective Demolition

C. Section 312319 - Dewatering

D. Division 31 - Earthwork for Structures and Pavements

E. Division 31 - Excavating, Backfilling and Compaction for Utilities

1.04 QUALITY ASSURANCE

A. Clearing Firm: Company specializing in the type of work required with a minimum 3 years of documented experience.

B. A testing laboratory provided by the Owner shall make such site inspections and tests as are deemed necessary. The Contractor shall coordinate with the testing laboratory and schedule work so as to permit a reasonable time for testing as the work progresses. Cost of wall testing Work requested by the Owner in regards to this work, and meeting the minimum specified requirements, shall be paid for by the Owner

1.05 PERMITS

A. Contractor shall comply with all permitting requirements of the regulatory water resource control agency during construction.
   1. California State Water Resources Control Board.

B. Should on site burning of brush be allowed, the Contractor shall apply for and obtain all necessary permits for this activity.

C. Contractor shall maintain a copy of all permits on-site and available for review by any regulatory agency as required, throughout the course of the work.

1.06 START OF WORK

A. Prior to initiating clearing and grubbing operations, field survey and stake the limits of construction.

B. Obtain the Owner's Project Manager's approval of the field survey.

C. Locate and inspect all existing on-site utilities.

D. Install all silt fences, hay bales and environmental fence along the limits of construction as indicated on the Drawings.

E. Obtain approval of proposed dewatering, erosion, sedimentation control measures and discharge procedures of storm water runoff from Owner and regional water resources control agencies.

F. Initiate clearing and grubbing operations.

1.07 SITE INSPECTION AND LOCATION OF EXISTING ON-SITE UTILITIES:

A. Prior to all work of this Section, carefully inspect the entire site and all existing items to be demolished and removed or to be left intact, and determine an orderly sequence for the performance of this work. Exact locations and alignment of existing buried utility lines are not known. Locate all existing utility lines and determine the requirements for disconnection and capping. Locate all active utilities traversing the area of work to be retained and determine the requirements for protection.

B. Locate all overhead utilities and powerlines and determine height restrictions. Do not operate equipment in the vicinity of overhead utilities and powerlines which may create a safety hazard.

C. Disconnection and protection of utilities: Preserve in operating condition all active utilities traversing the site and servicing adjacent structures. Protect all property including, but not necessarily limited to mains, manholes, catch basins, valve boxes, poles, guys, and other appurtenances.

1.08 PROTECTION

A. The contractor shall notify SOUTHERN CALIFORNIA DIG ALERT at 1-800-227-2600 at least two days prior to starting work and shall coordinate all work with utility company representatives. The existence and locations of existing underground facilities shown on the drawings were obtained from a search of available records. The contractor shall take precautionary measures to protect any existing facility shown on the drawings, and any other which is not of record or not shown on the drawings. The Contractor shall determine the exact location of all existing utilities before commencing the work, and shall be fully responsible for any and all damages which might be occasioned by the Contractor's failure to exactly locate and preserve any and all underground utilities.

B. The Contractor shall pothole all existing utilities at all crossing points and points of connection. The Contractor shall record exact horizontal and vertical locations of all pot-holed underground facilities. Notify the Owner of any conflicts or differences from positions indicated on the drawings. If potholes do not reveal the location of certain existing utilities, or if potholes reveal locations of existing utilities other than expected, the Contractor shall notify the Owner in writing, and shall not proceed further until the Owner provided direction.

C. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers.

1.09 DEWATERING AND STORM WATER POLLUTION PREVENTION

A. Dewatering: Provide for the disposal of surface and subsurface water, which may accumulate in open excavations, unfinished fills, or other low areas. Remove water by trenching where approved, pumping, or other methods to prevent softening of exposed surfaces. Contractor is responsible for obtaining and paying for any permits for dewatering through all jurisdictional agencies, including the local Regional Water Quality Control Board. Surface dewatering plan shall include the rerouting of any storm water runoff or natural drainage, if necessary, and shall comply with requirements of the City and the California State Water Resources Control Board. Construction water from dewatering or any other construction source shall not be allowed to discharge untreated to the public right-of-way, public or private storm drain systems, creeks/streams/lakes/ponds, other surface waters, flood control facilities, or onto adjacent properties. California Storm Water Best Management Practices and the guidance provisions set forth in the Storm Water Pollution Prevention Plan shall be complied with for all phases of the work.

B. Protection and Restoration of Surface: Protect newly graded areas from traffic, erosion, and settlements. Repair and reestablish damaged or eroded slopes, elevations or grades and restore surface construction prior to acceptance. Provide appropriate erosion control and sediment control measures to prevent water-borne soil from leaving the site. The Storm Water Pollution Prevention Plan will provide erosion and sedimentation control guidance to the contractor; however, the contractor shall be responsible to use the most appropriate Best Management Practices as necessary to ensure pollution and/or illegal discharges of storm water and non-storm water do not occur from the site. The contractor shall be responsible to clean up any soil deposited in the public right-of-way, public or private storm drain systems, creeks/streams/lakes/ponds and other surface waters, flood control facilities, or on adjacent properties. The contractor shall be responsible to protect storm drain catch basins and to prevent sediment from entering the public or private storm drain system during construction.

C. Storm Water Pollution Prevention Plan (SWPPP): If this project is greater than one acre in total disturbed area or is part of a larger common development, it is required to be permitted by the State Water Resources Control Board under Order No. 99-08 DWQ Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with Construction Activity (General Permit). A SWPPP shall be prepared for the site. Unless otherwise specified in the Division 1, if the Owner has not provided a SWPPP, it is the Contractor's responsibility to request

the document and Waste Discharge Identification Number (WDID #) from the Owner. Both documents shall be maintained on site for the duration of the construction project. These documents are public and may be reviewed by any regulating authority with appropriate identification. The contractor shall take whatever means necessary to prevent any illicit discharges of contaminated storm or non-storm water from the site. This includes, but is not limited to, providing a stock pile of erosion control materials for emergency installation, providing the means for installation of erosion control materials prior to and during storm events, monitoring and inspecting the site per the guidelines of the General Permit and SWPPP, and providing Sampling and Analysis as required by the General Permit and SWPPP.

1.10 SAFETY DURING CONSTRUCTION

A. The Contractor shall assume sole and complete responsibility for job site conditions during the course of construction of the project, including safety of all persons and property. This requirement shall be made to apply continuously and not be limited to normal working hours. Refer to General Provisions for additional requirements.

1.11 PROTECTION OF ADJACENT AREAS

A. The Contractor shall protect existing facilities and landscape outside the limits of work.

B. The Contractor shall exercise care to avoid damage to existing facilities to remain.

C. The Contractor shall take all means to avoid the spread of dust to adjacent property or the public right-of-way. The Contractor shall be responsible for street sweeping and cleaning of the public right-of-way and adjacent property.

D. Provide weather protection during the construction period to prevent erosion or sedimentation onto the public right-of-way or adjacent property

PART 2 - PRODUCTS

2.01 GRAVEL BAGS

A. Gravel sand bags shall be used onsite and serve as a storm drain inlet protection mechanism, as specified in the California Construction BMP Handbook and Greenbook.

2.02 TEMPORARY FIBER ROLLS

A. Temporary fiber rolls shall be used onsite and serve as a sediment runoff protection measure, as specified in the California Construction BMP Handbook and Greenbook.

PART 3 - EXECUTION

3.01 CLEANING

A. In all areas of the project, unless otherwise noted, remove and dispose of trees, snags, stumps, shrubs, brush, limbs, and other vegetative growth. Remove all evidence of their presence from the surface including sticks and branches greater than 1 inch in diameter or thickness. Remove and dispose of trash piles, rubbish, and stockpiled organic material. Protect trees, shrubs, and vegetative growth which are not designated for removal.

B. Clearing limits must be approved by the Owner prior to beginning clearing operations.

C. Do not begin clearing until vegetation to be relocated has been removed.

D. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil

3.02 GRUBBING

A. In all areas of the project, unless otherwise noted, remove all stumps, roots, brush and other debris greater than 1 inch in diameter to a depth of not less than two feet below the subgrade.

B. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

3.03 SELECTIVE CLEARING AND/OR GRUBBING

A. Special attention shall be given by the Contractor to saving, protecting, and preserving any existing trees, shrubs or other vegetation so designated by the Owner. Selective clearing and/or grubbing shall be performed in locations indicated on the drawings and other areas specified by the Owner at no additional cost to the Owner. The Owner or the Owner's Representative will select and mark, or otherwise designate, trees, ornamentals or other vegetation to be preserved, before or after award of the contract or initiation of construction. Contractor shall install an approved wood or enviro fence around designated vegetation at a minimum distance of ten feet from the trunk or at a point equal to 2 of the radius of the drip line from the trees, ornamentals, or other vegetation to be preserved.

B. If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

C. Clearing limits must be approved by the Owner prior to beginning clearing operations.

D. Provide protection for roots over 1-1/2 inch diameter cut during construction operations. Coat cut faces with an emulsified asphalt, or other acceptable coating, formulated for use on damaged plant tissues. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.

3.04 TOPSOIL EXCAVATION

A. Excavate topsoil from entire site, without mixing with foreign matter for use in finish grading.

B. Do not excavate wet topsoil.

C. Stockpile in area designated on site and protect from erosion. Stockpile material and stabilize with temporary seeding until ready for re-use or disposal.

D. Excess topsoil not intended for re-use, shall be removed from the site and disposed of properly by the Contractor

3.05 DISPOSAL OF MATERIALS

A. Combustible materials may be disposed of by burning within the limits of construction, if prior approval is obtained from the appropriate governmental authorities and Owner. If such approval for burning is not obtainable, then haul away and properly dispose of combustible materials off of property. All burning shall be completed with the use of an air curtain incinerator.

B. The Contractor shall not allow any debris to accumulate on-site for more than 48 hours and shall remove such debris when requested by the Owner's Representative.

END OF SECTION

SECTION 024119

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 SCOPE

A. Demolition and removal of portions of buildings or structures.

B. Required demolition as indicated on the Drawings.

C. Temporary barriers to protect remainder of occupied space.

D. Selective demolition of built site elements.

E. Selective demolition of building elements for alterations purposes.

F. Abandonment and removal of existing utilities and utility structures

1.02 RELATED SECTIONS

A. Section 014000 - Quality Control: Construction procedures for cutting and patching.

B. Section 015000 - Temporary Facilities and Service: Site fences, security, protective barriers, and waste removal.

C. Section 016000 - Product Requirements: Handling and storage of items removed for salvage and relocation.

D. Section 024113 - Site Clearing: Vegetation and existing debris removal; topsoil removal.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

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

1.04 SUBMITTALS

A. Proposed Demolition Activities:
   1. Submit proposed schedule of demolition activities. Indicate:
      a. Starting and ending dates for each activity as appropriate.
      b. Interruption and restoration of utility services.
   2. Submit proposed methods of operations.
   3. Submittal of proposed demolition activities will also be reviewed by the Owner only to determine that proposed activities will not interfere with the owner's operations.

B. Photographs: Before starting work, file with the Owner photographs documenting existing conditions that later could be mistaken for damage caused by demolition operations.

C. Project Record Documents:
   1. Identify location of capped utilities.
   2. Indicate unanticipated structural, electrical, or mechanical conditions.

1.05 PROJECT CONDITIONS

A. Occupancy: Adjacent structure will not be vacated during demolition activities.

B. Existing Conditions:
   1. After the project is begun, the Contractor is responsible for the condition of structures to be demolished. The Owner does not warrant that the condition of structures to be demolished will not have changed since the time of inspection for bidding purposes.

C. Unforeseen Conditions: Should unforeseen conditions be encountered that affect design or function of project, investigate fully and submit an accurate, detailed, written report to the Owner. While awaiting the Owner's response, reschedule operations if necessary to avoid delay of overall project.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that utilities have been disconnected and sealed.

B. Survey existing conditions and correlate with drawings and specifications to determine extent of demolition required.

C. Insofar as is practicable, arrange operations to reveal unknown or concealed structural conditions for examination and verification before removal or demolition.

D. Verify actual conditions to determine in advance whether removal or demolition of any element will result in structural deficiency, overloading, failure, or unplanned collapse.

3.02 PREPARATION

A. Protection:
   1. Provide for the protection of persons passing around or through the area of demolition.
   2. Perform demolition so as to prevent damage to adjacent improvements and facilities to remain.
   3. Protect walls, floors, and other new or existing work from all damage during demolition operations.

B. Temporary Partitions:
   1. Provide substantial construction designed by the Contractor to provide effective protection as required.
      a. Exterior closures: Weatherproof, constructed to prevent water leakage, insulated to prevent excessive heat loss or gain to occupied areas, and sealed to prevent excessive air filtration.
   2. Construct temporary partitions in a manner at least equal to the following (or superior, if necessary to provide effective protection specified):
      a. Wood studs covered with plywood sheathing.
      b. Gypsum-board surfaces adjacent to occupied areas, with joints taped.

C. Structural Support:
   1. Construct and maintain shoring, bracing, and supports as necessary to ensure the stability of structures.
   2. Increase or add new supports as required by the progress of the work.

D. Damages: Without cost to the owner and without delay, repair any damages caused to facilities to remain.

3.03 GENERAL PROCEDURES

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Comply with applicable requirements of NFPA 241.
   2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
   3. Do not close or obstruct roadways or sidewalks without permit.

4. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
5. Do not begin removal until receipt of notification to proceed from Owner
6. Protect existing structures and other elements that are not to be removed.
    a. Provide bracing and shoring.
    b. Prevent movement or settlement of adjacent structures.
    c. Stop work immediately if adjacent structures appear to be in danger.
7. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
8. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.
9. Perform demolition in a manner that maximizes salvage and recycling of materials.
    a. Dismantle existing construction and separate materials.
    b. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.
10. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.04 UTILITY SERVICES

A. Arrange with utility companies and shut off indicated utilities serving structures.

B. Disconnect and cap indicated utilities before starting demolition operations.

C. Identify location of capped utilities on project record documents.

D. Obtain written approval from Owner before interrupting existing utilities.
    1. All service interruptions which affect existing utilities for ongoing Owner operations shall be assumed to be done after hours.

E. Any work to existing utilities for ongoing Owner operations shall be coordinated at least 1 week in advance. Notify the Owner at least 72 hours in advance of changeover for permanent and temporary utilities.

F. Bypass Connections: Provide as necessary to maintain service to occupied areas.

G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

3.05 EXPLOSIVES

A. Do not use explosives.

3.06 POLLUTION CONTROLS

A. Control as much as practicable the spread of dust and dirt.

B. Observe environmental protection regulations.
    1. Comply with SWPPP as regulated by the local authority having jurisdiction.

C. Do not allow water usage that results in freezing or flooding.

D. Do not allow adjacent improvements to become soiled by demolition operations.

3.07 DEMOLITION - GENERAL

A. Remove: Unless items are otherwise indicated to be relocated, they shall be removed from the park immediately.
    1. Do not store removed items on the site, including items of value to the Contractor.

B. Remove and Turnover to Owner: Carefully remove noted items without damage beyond existing condition. Clean, package, and identify if required. Deliver item to Owner's storage in the park and receive a signed receipt from the facility project manager.

C. Remove and Relocate: Remove items indicated; clean, service, and otherwise prepare for service; turn over to Contractor to be re-installed in new location shown on the drawings.

D. Existing to Remain: Construction or items indicated to remain shall be protected against damage during demolition operations. Where practicable, and with the Owner's permission, the Contractor may elect to remove items to a suitable storage location during demolition and then properly clean and reinstall the items.

E. Perform work in a systematic manner.

F. Demolish and remove existing construction only to the extent required by new construction and as indicated in the contract documents.

G. Perform selective demolition using methods which are least likely to damage work to remain and which will provide proper surfaces for patching.

H. Remove debris daily.

I. Masonry: Detach masonry to be demolished from adjoining construction to remain with power-driven masonry saws or hand tools.

J. Use any methods permitted by governing regulations and the requirements of the contract documents.

3.08 DEMOLITION ON OR BELOW GRADE

A. Where portions of concrete slabs-on-grade are to be removed, first outline the portion with a concrete saw to a depth of at least 1 inch.

B. Keep demolition materials out of the sight of public view.

C. Remove concrete slabs-on-grade and its related granular base.

D. Completely remove below-grade construction, including foundations and footings.

3.09 DEMOLITION FOR SEPARATE CONTRACTS

A. The work of this Contract shall include demolition as required by Separate Contracts listed in Section 010300 at the time of Bid Receipt.
   1. This Contractor shall examine work of Separate Contracts to determine required extent of demolition.
   2. This Contractor shall include in its Bid the full cost of repairs to existing improvements to restore them to their original conditions, matching existing to maximum, extent possible.
   3. This Contractor shall coordinate and cooperate with the work of each separate Contractor.

3.10 DISPOSAL OF DEMOLISHED MATERIALS

A. Promptly dispose of materials resulting from demolition operations. Do not allow materials to accumulate on site.

B. Comply with all local ordinance related to construction and demolition recycling including, but not limited to, County of San Diego - Sections 68.508 through 68.518 of the County Code of Regulatory Ordinances.

C. Transport materials resulting from demolition operations and legally dispose of off-site.

D. Do not burn removed materials on project site.

E. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

3.11 CLEANING

A. Leave site in clean condition, ready for subsequent work, including:
   1. Remove tools and equipment. Disposal of all scrap.
   2. Broom clean interior areas.
   3. Return structures and surfaces to remain to condition existing prior to commencement of demolition.
   4. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
   1. Footings.
   2. Foundation walls.
   3. Retaining walls
   4. Slabs-on-grade.
   5. Suspended slabs.
   6. Ride (mat and piers) foundations.

1.02 RELATED SECTIONS:

A. Division 01 Section 014600 “Structural Tests and Special Inspections.

B. Division 31 Section "Earthwork" for compacted fill under slabs-on-grade.

C. Division 32 Section " Concrete Paving" for concrete pavement and walks.

1.03 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: fly ash and other pozzolans, subject to compliance with requirements.

1.04 ACTION 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. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   1. Location of construction joints is subject to approval of the Architect.

E. Samples:
   1. Concrete with color pigment.
   2. Waterstops.

F. Mockup/First Article: Rubbered Finish at exposed smooth-formed concrete.\
   1. Area: Nine (9) square feet.
   2. Location: As approved by Owner’s Project Manager,

1.05 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials.
   2. Admixtures.

3. Form-release agents.
4. Steel reinforcement and accessories.
5. Waterstops.
6. Curing compounds.
7. Bonding agents.
8. Adhesives.
9. Vapor retarders.
10. Repair materials.

C. Field quality-control reports.

D. Minutes of preinstallation conference.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

H. Preinstallation Conference: Conduct conference at Project site.
1. Before submitting design mixtures, review concrete design mixtures and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Concrete subcontractor.
e. Owner’s representative.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, forms and form

removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.01 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
   1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
   1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
   2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
   3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.02 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

2.03 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.04 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement: ASTM C 150, Type I/II, gray. Supplement with the following:
      a. Fly Ash: ASTM C 618, Class F.

B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
   1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.05 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
   2. Retarding Admixture: ASTM C 494/C 494M, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Axim Italcementi Group, Inc.; CATEXOL CN-CI.
      b. BASF Construction Chemicals - Building Systems; Rheocrete CNI.
      c. Euclid Chemical Company (The), an RPM company; EUCON BCN.
      d. Grace Construction Products, W. R. Grace & Co.; DCI.
      e. Sika Corporation; Sika CNI.

D. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
   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. ChemMasters.
      b. Davis Colors.
      c. Dayton Superior Corporation.
      d. Hoover Color Corporation.
      e. Lambert Corporation.
      f. QC Construction Products.
      g. Rockwood Pigments NA, Inc.
      h. Scofield, L. M. Company.
      i. Solomon Colors, Inc.
   2. Color: As selected by Architect from manufacturer's full range.

E. Crystalline Waterproofing Additive: Concrete waterproofing system shall be of the crystalline type that chemically controls and permanently fixes a non-soluble crystalline structure throughout the capillary voids of the concrete. The system shall cause the concrete to become sealed against

the penetration of liquids from any direction, and shall protect the concrete from deterioration due to harsh environmental conditions.

1. Products: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
   a. Xypex Chemical Corporation; XYPEX Admix C-500.

2.06 WATERSTOPS

A. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Adeka Ultra Seal/OCM, Inc.; Adeka Ultra Seal.
      b. Greenstreak; Hydrotite.
      c. Vinylex Corp.; Swellseal.

2.07 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Fortifiber Building Systems Group; Moistop Ultra 10.
      b. Insulation Solutions, Inc.; Viper VaporCheck 10.
      c. Meadows, W. R., Inc.; Perminator 10 mil.
      d. Raven Industries Inc.; Vapor Block 10.
      e. Reef Industries, Inc.; Griffolyn 10 mil Green.
      f. Stego Industries, LLC; Stego Wrap 10 mil Class A.

2.08 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. BASF Construction Chemicals - Building Systems; Confilm.
      b. ChemMasters; SprayFilm.
      c. Conspec by Dayton Superior; Aquafilm.
      d. Dayton Superior Corporation; Sure Film (J-74).
      e. Edoco by Dayton Superior; BurkeFilm.
      f. Euclid Chemical Company (The), an RPM company; Eucobar.
      g. Kaufman Products, Inc.; Vapor-Aid.
      h. L&M Construction Chemicals, Inc.; E-CON.
      i. Meadows, W. R., Inc.; EVAPRE.
      j. Nox-Crete Products Group; MONOFILM.
      k. Sika Corporation; SikaFilm.
      l. Symons by Dayton Superior; Finishing Aid.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. BASF Construction Chemicals - Building Systems; Kure 200.
b. ChemMasters; Safe-Cure Clear.
c. Conspec by Dayton Superior; W.B. Resin Cure.
d. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
e. Edoco by Dayton Superior; Res X Cure WB.
f. Euclid Chemical Company (The), an RPM company; Kurez W VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. L&M Construction Chemicals, Inc.; L&M Cure R.
i. Meadows, W. R., Inc.; 1100-CLEAR.
j. Nox-Crete Products Group; Resin Cure E.
k. Symons by Dayton Superior; Resi-Chem Clear.

F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. BASF Construction Chemicals - Building Systems; Kure 1315.
b. ChemMasters; Polyseal WB.
c. Conspec by Dayton Superior; Sealcure 1315 WB.
d. Edoco by Dayton Superior; Cureseal 1315 WB.
e. Euclid Chemical Company (The), an RPM company; Super Diamond Clear VOX; Luster-Seal WB 300.
f. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
g. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
h. Meadows, W. R., Inc.; Vocomp-30.
i. Symons by Dayton Superior; Cure & Seal 31 Percent E.
2. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.09 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.

B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
1. Types I and II, non-load bearing, Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.10 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
   1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
   2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
   3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
   4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash: 20 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing, high-range water-reducing or plasticizing admixture in all structural concrete, for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
   3. Use high-range water-reducing admixture or plasticizing admixture in pumped concrete, concrete required to be watertight, and concrete with a water-cementitious materials ratio less than or equal to 0.45. (All 5000 psi concrete).
   4. Use corrosion-inhibiting admixture in all 5000 psi concrete mixtures, minimum 2 gal./cubic yard.
   5. Use air-entraining admixture at the manufacturer’s prescribed rate, to result in concrete at the point of placement having air content of 6% for 1 inch aggregate.
   6. Use Xypex C-500 Crystalline admixture in all 5000 psi concrete mixtures, minimum 3% dosage rate by weight of cememtitious materials.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved sample.

F. Maximum allowable shrinkage value for all 5000 psi concrete shall be 500-millionths (0.05 percent) with an allowable variation of 15 percent. Unit shrinkage (expressed in percentage of length) shall be determined in accordance with ASTM C 157-80, based upon the average value of (3) specimens of 4 inches by 4 inches or 3 inches by 3 inches with effective length of 10 inches. Specimens shall be tested after 21 days of actual drying time.

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS AND RIDE FOUNDATIONS

A. Footings: Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 4000 psi at 28 days.
   2. Maximum Water-Cementitious Materials Ratio: 0.50.
   3. Slump Limit: 4 inches or 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.

4. Air Content: 4.5 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

B. Foundation Walls and Retaining Walls: Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 4000 psi at 28 days.
   2. Maximum Water-Cementitious Materials Ratio: 0.45.
   3. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
   4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.

C. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 4000 psi at 28 days.
   2. Minimum Cementitious Materials Content: 540 lb/cu. yd.
   3. Slump Limit: 4 inches, plus or minus 1 inch.
   4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
   5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

D. Suspended Slabs (Slabs on Metal Deck): Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 5000 psi at 28 days.
   2. Maximum Water-Cementitious Material Ratio: 0.40.
   3. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
   4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.
   5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

E. Ride Foundations (Mat and Piers): Proportion normal-weight concrete mixture as follows:
   1. Minimum Compressive Strength: 4000 psi at 28 days.
   2. Maximum Water-Cementitious Materials Ratio: 0.45.
   3. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
   4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.

2.13 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, 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

3.01 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
1. Install keyways, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.03 REMOVING AND REUSING FORMS

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

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
   1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.05 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
   1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
   1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.06 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
   2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
   3. Locate joints for beams, and slabs in the middle third of spans.
   4. Locate horizontal joints in walls and columns at underside of floors, slabs, and beams and at the top of footings or floor slabs.
   5. Space vertical joints in walls at 50 feet maximum spacing. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.07 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

3.08 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

F. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.09 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, or to be covered with a coating or covering material applied directly to concrete.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 FINISHING FLOORS AND SLABS (UNLESS COVERED IN DIVISION 32 SECTION "CONCRETE PAVING")

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated to receive trowel finish.

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a trowel finish to surfaces indicated or exposed to view or to be covered with resilient flooring, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

D. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
   1. Comply with finish tolerances for trowel-finished floor surfaces.

E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
   1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.12 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Im-

mediately repair any holes or tears during curing period using cover material and waterproof tape.
    a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    b. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.13 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
    1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.14 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
    1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
    2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
    3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
   1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01-inch-wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
   2. After concrete has cured at least 14 days, correct high areas by grinding.
   3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
   4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
   5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
   6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
   7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.15 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Refer to Division 01 Section 014600 Structural Test and Special Inspections.

B. Inspections:
   1. Steel reinforcement placement.
   2. Steel reinforcement welding.
   3. Headed bolts and studs.
   4. Verification of use of required design mixture.
   5. Concrete placement, including conveying and depositing.
   6. Curing procedures and maintenance of curing temperature.
   7. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M.
    a. Cast and laboratory cure three sets of two standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days. Hold the final set of specimens for testing at 56 days if the 28-day compressive strength test fails to meet the required strength.
    a. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
7. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
8. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION

SECTION 035300

CONCRETE FLOOR TOPPING

PART 1 - GENERAL

1.01 RELATED SECTIONS

A. Section 033000: Cast-in-Place Concrete – General.

B. Section 321300: Concrete Paving.

1.02 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM C 33 - Specifications for Concrete Aggregates.

C. ASTM C 94 - Specifications for Ready-Mix Concrete.

D. ASTM C150 - Specifications for Portland Cement.

1.03 SUBMITTALS

A. Furnish data, samples, laboratory test reports, and material certificates as specified in Section 033000.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cement and Aggregates:
   1. Portland Cement: ASTM C 150, Type I or Type III.
   2. Standard Aggregate: ASTM C 33, and as follows
      a. Fine Aggregate, consisting of sand or crushed stone screening, clean, hard, free from deleterious matter. Grade by weight to pass sieves as follows:

3/8	[10.0	mm]	:	100	percent
No. 4	[5.0	mm]	:	95-100	percent
No. 8	[2.5	mm]	:	80-90	percent
No.16	[1.2	mm]	:	50-75	percent
No.30	[600.0	mm]	:	30-50	percent
No.50	[315.0	mm]	:	10-20	percent
No.100	[160.0	mm]	:	2-5	percent

      b. Coarse Aggregate, consisting of gravel or crushed stone, clean, hard, free from deleterious matter. Graded by weight to pass sieves as follows:

1/2	[12.5	mm]	:	100	percent
3/8	[10.0	mm]	:	30-50	percent
No. 4	[5.0	mm]	:	0-15	percent
No. 8	[2.5	mm]	:	0-5	percent

B. Topping mix
   1. Standard Topping: Design mix to produce topping material with the following characteristics:
      a. Compressive strength: 4000 psi [280 kg/cm2, 28 MPa] in 28 days.
      b. Slump: 8 inches [20 cm] maximum at point of placement for concrete containing high-range water-reducing admixture and 3 inches [8 cm] maximum for other concrete.
      c. Maximum W/C Ratio: 0.45.

C. Concrete Admixtures: Refer to Section 033000.

D. Structural Bonding Compounds: Refer to Section 033000.

2.02 MIXING

A. Provide batch type mechanical mixer for mixing topping material at project site. Equip batch mixer with a suitable charging hopper, water storage tank, and a water-measuring device.

B. Use only mixers which are capable of mixing aggregates, cement, fibers and water into a uniform mix within specified time, and of discharging mix without segregation.

C. Ready-mixed topping may be used when acceptable to the Owner. When acceptable, furnish ready-mixed topping complying with requirements of ASTM C 94.

2.03 FINISH

A. Refer to architectural drawings for specified texture and color.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Remove dirt, loose material, oil, grease, paint or other contaminants, leaving a clean surface.

B. Prior to placing topping mixture, thoroughly dampen slab surface but do not leave standing water. Over dampened surface, apply specified bonding compound or epoxy adhesive. Place topping mix while non-rewettable bonding compound or epoxy adhesive is still tacky.

C. Provide necessary chairs or reinforcing supports, and maintain position of reinforcing mesh.

D. Mark location of joints in base slab and place the joints in top course directly over them.

3.02 PLACING AND COMPACTING

A. Float Finish: Spread topping mixture evenly over prepared base to the required elevation and strike off. Use highway straightedge, bull float, or darby to level surface. After the topping has stiffened sufficiently to permit the operation, and water sheen has disappeared, float the surface at least twice to a uniform sandy texture. Re-straighten where necessary with highway straightedge. Refer to Section 033000 for additional information.

B. Trowel Finish: After floating, begin first trowel finish operation using power driven trowels. Continue troweling until surface is ready to receive final troweling. Begin final troweling when a ringing sound is produced as trowel is moved over surface. Refer to Section 033100 for additional information.

C. Stamped Pattern Finish: Contractor is to provide a stamped pattern finish where shown on the Drawings or in Schedules. Refer to Section 321300 for additional information.

3.03 CURING AND PROTECTION

A. Cure to protect topping applications and finishes as specified in Section 033000.

3.04 ACCEPTANCE

A. Failure of concrete topping to bond to substrate (as evidenced by a hollow sound when tapped), or disintegration or other failure of topping to perform as a floor finish, will be considered failure of materials and workmanship. Repair or replace toppings in areas of such failures, as directed.

END OF SECTION

SECTION 036000

GROUTING FOR RIDE COLUMN BASES

PART 1 - GENERAL

1.01 SCOPE

A. This Section supplements the Drawings and specifies project technical requirements, and defines workmanship, quality control procedures, curing, testing and final acceptance of grout for column based of this Project.

1.02 RELATED DOCUMENTS

A. The general provisions of the Contract, including General Contract Conditions and General Requirements apply to the work specified in this Section.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 033700 - Grout Procedures.

B. Ride Manufacturer's Drawings.

1.04 QUALITY ASSURANCE

A. Perform the grouting work in conformance with the procedures recommended by the manufacturer of the grout.

B. Submit certificates of compliance from the manufacturer of the grout or from a recognized Testing Agency confirming compliance with these Specifications.

C. Cooperate with a field service representative of the grout manufacturer during initial planning for mixing, placing and curing of the grout, as well as the start of placing the grout.

D. Testing and Inspection:
   1. Perform testing and inspection in accordance with Section 014000.
   2. Make a set of two-inch cubes for compression testing of the grout. Make at least one set of cubes for each day of grouting or for each ten bases or portion thereof grouted per day.

E. Codes and Standards: Comply with provisions of the latest edition of the following codes, specifications and standards, except where more stringent requirements are shown or specified:
   1. ASTM C 109-88 "Test Method for Compressive Strength of Hydraulic cement Mortars (Using 2-inch or 50 mm cube specimens).
   2. ASTM C 309-89 "Specification for Liquid Membrane-Forming Compounds for Curing Concrete".
   3. Corps of Engineers CRD-C 79 "Method of Test for Flow of Grout Mixtures" (flow cone method).

PART 2 - PRODUCT

2.01 MATERIALS

A. Product: Sure-Grip High Performance Grout as manufactured by Dayton Superior Corporation, Miamisburg, OH (800) 745-3700, www.daytonsuperior.com
   1. Non-shrink, non-corrosive, non-metallic cementitious engineered grout.
   2. Substitutions: No substitutions.

B. Install per manufacturer's recommendations. Provide flowable mix for applications under ride supports.

C. Use grout materials consisting of a factory-produced mixture of natural fine aggregates, portland cement and chemical admixtures intended to retard set and reduce the water required to obtain the desired fluidity. Use a mixture which is:
   1. Free of agents that produce or release gases
   2. Free of oxidizing catalysts
   3. Free of inorganic accelerators including chlorides
   4. Has the following characteristics when mixed to a fluid consistency having an efflux time from 22 to 25 seconds as measured by CRD-C 79:
      a. Show no visible bleeding or settlement for up to two hours after being mixed and maintained at 45° F. or higher as measured with a one-half gallon grout sample placed in a glass-plate-covered one gallon container.
      b. Maintain firm, full contact with a firmly held steel plate as evidenced by soundings at the ages of 1, 7, and 14 days as well as by visual observation after stripping. Test procedure to be as recommended by the manufacturer.
      c. Provide compressive strengths as measured on two-inch cubes prepared and tested in accordance with ASTM C 109 as modified by the manufacturer's recommendations for placing, puddling, striking, and curing, as follows:

Age in Days	Cube Strength
1	5,000 psi
7	8,000 psi
28	10,000 psi

D. Use a membrane curing compound which conforms to ASTM C 309.

E. Use potable water.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. Assure that concrete surfaces to receive grout are free of laitance, clean, rough and reasonably level and have been wet cured.

B. Do not use membrane curing compounds on surfaces to receive grout.

C. Assure that steel base plate surfaces to be in contact with grout are clean, free of oil, grease, dirt and loose particles.

D. Assure that bolt holes in base plates are clean, free of oil, grease, dirt and loose particles.

E. Saturate concrete, forms and bolt holes immediately before placing grout.

F. Remove free water from forms, concrete and bolt holes immediately prior to grouting.

3.02 FORMWORK

A. Design and construct formwork to be rigid, mortar-tight, providing rapid, continuous and complete filling of the space to be grouted.

B. Use side forms which are not less than four inches (4”) clear of base plate (horizontally) and at least one inch (1”) higher than the bottom surface of the base plate.

C. Assure mortar-tightness of form by caulking the outside form joints using mortar made of sand and Portland cement or by other methods recommended by the manufacturer and satisfactory to the Owner.

D. Forms may be removed when grout is completely self-supporting. Cut back the edges of the grout with a trowel for a forty-five degree (45º) chamfer finish from the lower edge of the base plate on all sides.

3.03 MIXING

A. Perform mixing in a paddle-type mixer or other mixer acceptable to the Manufacturer and Owner.

B. Perform mixing adjacent to the location where the grout is to be placed in a rapid and continuous manner, avoiding excess water, and hence, bleeding.

C. Mix for not less than 3 minutes, place immediately after mixing, use mixing water no warmer than 80° F [27° C].

D. Do not re-temper grout.

E. Maintain a placing temperature between 45° F [7° C] and 75° F [24° C].

F. In hot weather, use iced water to control grout temperature during mixing and placing.

G. Do not vibrate grout nor overwork it by puddling excessively.

3.04 INSTALLATION

A. Install per manufacturer's recommendations.

B. Provide flowable mix for applications under ride supports; dry or fluid consistency should not be used.

3.05 CURING AND PROTECTION

A. Cover exposed surfaces with wet burlap or other means acceptable to the Owner and maintain at 45° F [7° C] to 75° F [24° C] for twenty-four (24) hours or more after placing and above 40° [4° C] Fahrenheit thereafter until a cube compression strength of 4000 psi [280 kg/cm2, 28 MPa] has been attained, on field-cured cubes.

B. Membrane-forming curing compound may be used after twenty-four (24) hours if permitted by the Manufacturer and Owner.

C. Do not cure grout by the use of coke-fired salamanders.

END OF SECTION

SECTION 051200

STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Structural steel.

B. Grout.

1.02 RELATED SECTIONS:

A. Section 014000 “Quality Control Procedures” for independent testing agency procedures and administrative requirements.

B. Section 014600 " Structural Tests and Special Inspections."

C. Section 053100 "Steel Decking" for field installation of shear connectors through deck.

D. Section 055000 "Metal Fabrications" for miscellaneous steel fabrications and other metal items not defined as structural steel.

E. Division 9 Painting Sections for surface-preparation and priming requirements.

F. Section 133419 "Metal Building Systems" for pre-engineered metal buildings.

1.03 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.04 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.
   1. Select and complete connections using schematic details indicated and AISC 360.
   2. Use ASD; data are given at service-load level.

B. Moment Connections: Type FR, fully restrained.

C. Construction: Combined system of moment frames and braced frames.

1.05 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
   5. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer and fabricator.

B. Welding certificates.

C. Mill test reports for structural steel, including chemical and physical properties.

D. Product Test Reports: For the following signed by manufacturer certifying that the products comply with requirements:
   1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   2. Tension-control, high-strength bolt-nut-washer assemblies.
   3. Shear stud connectors.
   4. Shop primers.
   5. Nonshrink grout.

E. Source quality-control reports.

1.07 QUALITY ASSURANCE

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

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

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Comply with applicable provisions of the following specifications and documents:
   1. AISC 303.
   2. AISC 360.
   3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

E. Preinstallation Conference: Conduct conference at Project site.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Clean and relubricate bolts and nuts that become dry or rusty before use.
   2. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.09 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

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

PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M.

B. Channels and Angles: ASTM A 36/A 36M.

C. Plate and Bar: ASTM A 36/A 36M.

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.

E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
   1. Weight Class: As indicated.
   2. Finish: Black except where indicated to be galvanized.

F. Welding Electrodes: Comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; with ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
   1. Finish: Plain.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
   1. Finish: Plain.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex or round head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.
   1. Finish: Plain.

D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

E. Unheaded Anchor Rods: ASTM F 1554, Grade 36.
   1. Configuration: As indicated.
   2. Nuts: ASTM A 563 heavy-hex carbon steel.
   3. Plate Washers: ASTM A 36/A 36M carbon steel.
   4. Washers: ASTM F 436, Type 1, hardened carbon steel.
   5. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

F. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.
   1. Nuts: ASTM A 563 heavy-hex carbon steel.
   2. Plate Washers: ASTM A 36/A 36M carbon steel.
   3. Washers: ASTM F 436, Type 1, hardened carbon steel.
   4. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

G. Threaded Rods: ASTM A 36/A 36M.
   1. Nuts: ASTM A 563 heavy-hex carbon steel.
   2. Washers: ASTM F 436, Type 1, hardened carbon steel.
   3. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.

2.03 PRIMER

A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

B. Galvanizing Repair Paint: ASTM A 780.

2.04 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: Dayton Superior Sure-Grip high performance grout. Install per manufacturers' recommendations. Provide flowable mix for applications under ride supports and base plates.

2.05 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
   1. Camber structural-steel members where indicated.
   2. Fabricate beams with rolling camber up.
   3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
   4. Mark and match-mark materials for field assembly.
   5. Complete structural-steel assemblies, including welding of units, before starting shop-priming or galvanizing operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning.

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
   2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.06 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened unless noted otherwise.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.07 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   3. Surfaces to be high-strength bolted with slip-critical connections.
   4. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 6, NACE No. 3, “Commercial Blast Cleaning.”

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
   2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.08 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
   1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.

2.09 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
   1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
   1. Liquid Penetrant Inspection: ASTM E 165.
   2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
   3. Ultrasonic Inspection: ASTM E 164.

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in in-

tensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

3.03 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base and Bearing Plates: Clean concrete- bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
   1. Set plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of baseplate.
   3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.04 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened unless noted otherwise.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    a. Liquid Penetrant Inspection: ASTM E 165.
    b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
    c. Ultrasonic Inspection: ASTM E 164.

D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
    1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
    2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
    1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION

SECTION 053100

STEEL DECKING

PART 1 - GENERAL

1.01 SECTION INCLUDES:

A. Roof deck.

B. Composite floor deck.

1.02 RELATED SECTIONS:

A. Section 014600 “Structural Tests and Special Inspection.”

B. Section 033000 "Cast-in-Place Concrete" for normal-weight structural concrete fill over steel deck.

C. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.

D. Division 07 “Thermal and Moisture Protection” for roofing.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:
   1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.04 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

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 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

2.02 ROOF DECK

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. Canam United States; Canam Group Inc.

2. Consolidated Systems, Inc.; Metal Deck Group.
3. Epic Metals Corporation.
4. Nucor Corp.; Vulcraft Group.
5. Verco Manufacturing Co.
6. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
7. Canam United States; Canam Group Inc.
8. Consolidated Systems, Inc.; Metal Deck Group.
9. Epic Metals Corporation.
10. Nucor Corp.; Vulcraft Group.
11. Verco Manufacturing Co.
12. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
1. Galvanized-Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33, G90 zinc coating.
2. Deck Profile: Type WR, wide rib.
3. Profile Depth: 1-1/2 inches.
4. Design Uncoated-Steel Thickness: 0.0474 inch.
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped.

2.03 COMPOSITE FLOOR DECK

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. Canam United States; Canam Group Inc.
2. CMC Joist & Deck.
3. Consolidated Systems, Inc.; Metal Dek Group.
4. Epic Metals Corporation.
5. Marlyn Steel Decks, Inc.
6. Nucor Corp.; Vulcraft Group.
7. Verco Manufacturing Co.
8. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized-Steel Sheet: ASTM A653, Structural Steel (SS), Grade 33, G90 zinc coating.
2. Profile Depth: 2 inches.
3. Design Uncoated-Steel Thickness: 0.0474 inch.
4. Span Condition: Triple span or more.

2.04 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

C. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

D. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

F. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

G. Flat Sump Plates: Single-piece steel sheet, 0.0747-inch-thick, of same material and finish as deck. For drains, cut holes in the field.

H. Galvanizing Repair Paint: ASTM A 780.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. 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.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.03 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:
   1. Weld Diameter: 5/8 inch, nominal.
   2. Weld Spacing: as indicated.

B. Side-Lap: Fasten side laps of panels between supports, at intervals not exceeding the lesser of 1/3 of the span or 18 inches, and as follows:
   1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: Lapped 2 inches minimum.

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches apart with at least one fastener at each corner.
   1. Install reinforcing channels or zees in ribs to span between supports and weld.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.
   1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.04 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
   1. Weld Diameter: 3/4-inch, nominal.
   2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:
   1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 2 inches with end joints as follows:
   1. End Joints: Butted.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.06 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 054000

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Provide all light gage framing including but not limited to:
   1. Interior load bearing partitions with stud depths of 6 inches or greater
   2. Interior corridors, walkways and ceiling access unless noted
   3. Exterior walls and soffits
   4. Roof framing members
   5. Structural design

1.02 RELATED DOCUMENTS

A. The general provisions of the Contract, including General Contract Conditions and General Requirements apply to the work specified in this Section.

1.03 RELATED WORK SPECIFIED ELSEWHERE

A. Section 051200 - Structural Steel

B. Section 055000 - Metal Fabrications

C. Section 061000 - Rough Carpentry

1.04 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the latest edition of the following codes, specifications and standards, except where more stringent requirements are shown or specified:
   1. American Iron & Steel Institute (AISI): SG-671 Design of Cold-Formed Steel Structural Members, March 1986.
   2. American Society of Civil Engineers (ASCE): ASCE 7-95 Minimum Design Loads for Buildings and Other Structures.
   3. American Society for Testing and Materials (ASTM):
      a. A446-93 Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
      b. A525-93 General Requirements of Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
      c. A570-92 Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality (Re-approved 1993).
      d. A611-92 Steel, Sheet, Carbon, Cold-Rolled, Structural Quality.
      e. A780-93a Practice for Repair of Damaged Hot-Dip Galvanized Coatings.
   4. American Welding Society (AWS): Welding Sheet Steel in Structures.
   5. Florida Building Code, 2007 Edition with local amendments.

B. Welding shall be performed only by qualified operators using proper equipment for the type of work required.
   1. All structural field welding and shop welding is subject to Special Inspection as required by the authority having jurisdiction.

C. Welding, welding equipment, and welder's qualifications to meet the requirements of AWS D1.3. Qualify all welders.

D. Specialty Engineer: Calculations required for structural design shall bear seal and signature of professional engineer registered in the jurisdiction of the project and be under his/her direct

supervision. Maintain calculations on file and submit to Owner; see "Resumes", "Calculations" and "Cover Letter for Calculations" under SUBMITTALS.

1.05 DEFINITIONS

A. Gages: Metal gages referenced in this Section to have thicknesses not less than those listed below. Thickness indicated is base metal, exclusive of coatings. Where manufacturer's standard gage is less than specified below, furnish heavier gage to comply with thickness requirements.
   1. 12 gage: 0.1000 inch
   2. 14 gage: 0.0700 inch
   3. 16 gage: 0.0560 inch
   4. 18 gage: 0.0450 inch
   5. 20 gage: 0.0340 inch

1.06 DESIGN REQUIREMENTS

A. Engineer cold-formed metal framing to withstand Project wind loads (including soffit uplift), other live loads and dead loads without exceeding the allowable design work stress of the material involved, including anchors and connections.

B. Parameters:
   1. Stud Spacing: As shown on Drawings. If not shown, Specialty Engineer is to determine. However, stud spacing is not to exceed 24 inch centers.
   2. Stud Depth: As shown on Drawings. If not shown on Drawing, Specialty Engineer is to determine.
   3. Stud Gages:
      a. Supporting Vertical Live Load: Minimum 18 gage.
      b. Supporting Lateral Loads Only: Minimum 20 gage.
   4. Stud Width: Minimum 1-1/2 inches.
   5. Dead Load Support/ Anchors:
      a. Vertical Studs: Provide at lowest level that stud can fasten to.
      b. Horizontal Studs: Provide by either load bearing stud wall specified herein or structural steel framing specified elsewhere.
   6. Horizontal Load Support/Anchors:
      a. Vertical Studs: Provide at floors, roofs and girts.
      b. Horizontal Studs: Provide by either load bearing light gauge framing or structural steel framing specified elsewhere.

C. Stud/joists for support of exterior finish shall be types, gages, spacing and arrangement shown and required. Heavier gage or closer spacing may be required to meet design loads and deflection criteria.

D. Dead Load, vertical: Attached materials.

E. Loading requirements: As indicated on the Structural Drawings.

F. Deflection:
   1. Horizontal members: Not to exceed L/360.
   2. Vertical members:
      a. Interior: Not to exceed L/240.
      b. Exterior: Not to exceed L/360.

1.07 SUBMITTALS

A. Submit in accordance with Section 013000.

B. Product Data and Installation Instructions: Submit for each item of cold-formed metal framing and accessories.

C. Shop Drawings: Show detail, length, and location of all light gage materials, including any subassemblies to be shop fabricated. Show all welds, whether shop or field, and indicate all connections to steel frame, concrete, and masonry portions of the work.
   1. Show schematic framing elevations indicating stud spacing, locations of different gage members, if any, double or multiple studs, slide joints, bracing and bridging, and supplemental accessories and embeds required for proper installation and performance.
   2. Locate expansion/control joints which reflect coordination with exterior finishes and interior wallboard materials.
   3. Indicate number of fasteners and size and length of weld.
   4. Include identification code for different gage studs, if any.

D. Mill Certificates: Submit upon request by Owner.

E. Calculations: Submit calculations to the Owner for review; see "Cover Letter for Calculations" below.
   1. Show section moduli of primary load bearing members, and calculations of stresses and deflections for performance under design loading.
   2. Furnish calculations for studs, opening heads and sills, jamb studs, runner track, bracing, all related connections of members, attachment to cold-formed metal framing, and attachment to concrete and structural steel members.
      a. Provide list of manufacturer names, ICBO numbers, sizes and capacities for members, fasteners and anchorage devices.
      b. Provide necessary dimensions including edge distance, end distance, embedment, spacing and other limitations required for compliance with ICBO or other acceptable approval report(s).
   3. Submittals may or may not be returned, and will not bear stamp of approval.
   4. Include structural analysis data and calculations generated by a qualified Specialty Engineer. See "Specialty Engineer" under QUALITY ASSURANCE.

F. Cover Letter for Calculations: Furnish cover letter, signed and sealed by the Specialty Engineer, with calculations submittal which states that the:
   1. Specialty Engineer has reviewed the shop drawings, and:
   2. Shop drawings accurately reflect the design intent of the calculations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide materials manufactured by one of the following:
   1. Clark Dietrich Building Systems, 800-543-7140 (East Coast) or 800-365-528 (West Coast), www.clarkdietrich.com
   2. Marino\WARE, 800-504-8199, www.marinoware.com
   3. MBA Metal Framing, 888-248-8076, www.mbastuds.com

2.02 MATERIALS

A. General:
   1. Provide light gage steel materials complying with requirements of AISI SG-671.
      a. Exterior Framing: Galvanized finish.
      b. Interior Framing: Galvanized finish.
   2. Galvanized members: G60 galvanized coating per ASTM A525 on steel members complying with ASTM A446 in the following grades:
      a. 16 gage and heavier: Grade D; minimum Fy = 50,000 psi.
      b. 18 gage and lighter and Tracks: Grade A; minimum Fy = 33,000 psi.
   3. Painted members: Prime painted with rust-inhibitive paint. Manufacturer's standard coating on steel members complying with the following:
      a. 16 gage and heavier: ASTM A570, Grade 50; minimum Fy = 50,000 psi.

b. 18 gage and lighter and Tracks: ASTM A611, Grade C; minimum Fy = 33,000 psi.

B. Studs: Provide punched members in depths as shown or scheduled; gage and section properties as required to meet or exceed DESIGN REQUIREMENTS specified in PART 1.

C. Tracks: Un-punched steel to match stud quality and finish.
1. Standard leg, (3/4" minimum), minimum 16-gauge.
2. Deep leg, (1-1/4" minimum), minimum 16-gauge.
3. Special deep leg, (1-3/4" minimum), minimum 14-gauge; use where studs "float" in track to accommodate vertical deflection of structure.

D. Accessories:
1. Bridging: Cold rolled channel, 1-1/2 inch minimum x 16 gage.
2. Vertical Slide Clips: 12 gage galvanized steel accessory by Incor or similar device to secure studs to structure and permit vertical movement of structure without loading stud.
3. Touch-up paint: #13F22 "Galva-Kote" zinc metal primer by Valspar; or approved equal.
4. Screw Fasteners: Size suitable for the conditions, subject to ICBO or other acceptable approval report. Low profile head where board coverings attach to framing, phillips washer-faced ("Phillips Round Washer" by Star or equal). Cadmium plated meeting requirements of FS QQ-P-416A, Type II, Class #1; 0.0005 inch thick.
5. Anchorage Devices: Hot-dip galvanized steel or stainless steel. Anchorage device selection must have ICBO number and be compatible with the base material to which anchorage is being made. Acceptable types include:
    a. Powder actuated fasteners.
    b. Power-driven anchor screws.
    c. Drilled expansion bolts.
6. Miscellaneous: As required for complete installation.

2.03 FABRICATION

A. Fabricate framing systems to meet or exceed DESIGN REQUIREMENTS specified in Part 1.

B. Fabricate all components of framing systems in accordance with standard specifications; cut to accurate sizes and lengths as required for satisfactory erection as shown on Drawings.

C. Welding: See QUALITY ASSURANCE in Part 1. Evidence of questionable weld quality will be cause to reject all welding and require certification of all welders by an independent testing laboratory. Cost of testing to be borne by Contractor.

D. Identification: All studs of different gage than base specification to receive painted identification stripe (nominal 1 inch wide) at approximately 1/3 points on both flanges. Provide separate and distinct color for each gage member delivered to job. All identification marking to be done at mill.

2.04 SPECIAL FEATURES

A. Jack Studs: Provide studs between bottom track and window and/or louver sills, between lintels and headers and top track, and elsewhere as required for support of attached materials and equipment.

B. Blocking: Provide blocking in framing for all wall-mounted items, including door stops, grab bars, handrails, equipment or casework.

C. Special Corner Plates: 16 gage galvanized bent plates, legs as required to fully cover adjacent studs, full height in maximum practical lengths; provide at all corners where stud does not completely fill corners; i.e. 45 and 60 degree corners.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install framing systems to meet or exceed DESIGN REQUIREMENTS specified in Part 1.
2. Install all components in accurate locations as indicated, true to line, level and plumb in accordance with applicable standard specifications and manufacturer's published details.
3. Install top and bottom tracks in accurate locations and anchor securely to structure.
4. Seat studs squarely in tracks with webs and flanges abutting track web.
5. Erect studs plumb and aligned at centers shown or specified and securely attach to flanges or web of bottom track. Attach studs to top track only where differential vertical movement cannot occur; see "Deflection" below.
6. Provide tracks in as long lengths as practicable; butt weld or splice where necessary.
7. Leave ready to receive finish materials.

B. Stud Spacing: Not more than 24 inches center to center.

C. Multiple Studs: Provide double studs at all expansion/control joint locations and multiple at all openings wider than 2 feet. Provide additional studs where shown, if indicated in manufacturer's instructions, or required to meet DESIGN REQUIREMENTS.

D. Expansion/Control Joints: Provide double studs, back to back, with 1/2 inch separation unless otherwise detailed.
   1. Coordinate with other sections attaching materials to framing under this Section for required expansion/control joint locations.
   2. Stabilizers: Provide at each through wall framing joint and at not more than 5 foot centers.
      a. Use nominal 3 foot lengths of bridging (sufficient to engage first stud on both sides of joint).
      b. Place through stud web and attach to one stud only of the two joint studs using bridge clips as specified for "Bridging" below. Do not attach stabilizer to framing on both sides of joint which prevents horizontal movement of joint.
      c. Verify wall bridging to discontinuous across joint.

E. Studs to be full height, unbroken between supporting structure. Where height exceeds available stud lengths, provide welded splices reinforced as required to develop the full strength of the section. Splices subject to the following requirements:
   1. Splices not permitted in middle one-third of height.
   2. Splices may not increase overall depth of section.
   3. Splices must be straight and maintain flush faces.

F. Bridging: Install with bridge clips attached to studs with screws or weld. Discontinue bridging at expansion and control joints. See Control/Expansion Joints above for stabilizers at these locations. Where structural steel framing occurs in wall, attach bridging with welded bridge clips. Install at manufacturer's recommended spacing but not less than the following:
   1. Walls from 5 feet to 10 feet high: One row at mid-span.
   2. Walls from 10 feet to 14 feet high: Two rows equally spaced.
   3. Walls over 14 feet: Rows spaced at 4 feet center to center.
   4. Walls with Floating Track Condition: One additional row within 8 inches of top of studs.

G. Deflection: Install vertical slide clips or special deep leg top track at all attachments to structure subject to live load deflection in accordance with manufacturer's standard details. Structure subject to live load deflection include roof beams and floor systems above grade. Note additional bridging requirement:
   1. Floating Track: Cut 1 inch short in length to allow for vertical movement and not be rigidly attached to track, studs must engage track 3/4 inch.

H. All field abrasions and welds to be coated/touched up with cold applied zinc primer specified in accordance with manufacturer's printed instructions.

I. Connections:
   1. All metal-to-metal connections screwed or welded unless otherwise shown on Drawings or required by conditions.

2. Welded connections, where required, to be as specified under "FABRICATION" in Part 2. Attach metal studs to steel frame of building with 3 inches of fillet weld at each stud or equivalent capacity.
    a. Track: Provide anchorage to substrate at 2 foot centers or closer as determined by Specialty Engineer.
    b. Concrete or Masonry Substrate: Attachment to be designed by Specialty Engineer so as not to damage reinforcing.
    c. Steel Substrate: Attachment to be designed by Specialty Engineer using welds or screws.
3. Detail all connections on shop drawings.

J. Special Corner Plates: Install special corner plates at designated outside corners over top of normal light gage framing as reinforcement.

END OF SECTION

SECTION 054500

SECONDARY METAL SUPPORT ASSEMBLIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Rigging and overhead secondary suspension systems for overhead objects.

B. Delegated design.

1.02 RELATED SECTIONS

A. Section 051200 - Structural Steel: Members for attachment.

B. Section 055000 - Metal Fabrications: Member for attachment.

C. Division 10 - Graphics

D. Divisions 9, 10, 13 - Theming

E. Division 23 - Mechanical

F. Division 26 - Electrical

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association.

C. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.

D. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements.

E. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.

F. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

G. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

H. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

I. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

J. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

K. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

L. ASTM A 276 Type 304 or 316L Stainless Steel for Bars, Plates, and Structural Shapes.

M. ASTM A320 for Stainless Steel Bolts, Nuts, and Washers.

N. ASTM A 325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric).

O. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

P. ASTM A 501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

Q. ASTM B 26/B 26M - Standard Specification for Aluminum-Alloy Sand Castings.

R. ASTM B 85 - Standard Specification for Aluminum-Alloy Die Castings.

S. ASTM B 177 - Standard Guide for Engineering Chromium Electroplating.

T. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

U. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

V. ASTM B 210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.

W. ASTM B 210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric).

X. ASTM B 211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

Y. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

Z. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society.

AA. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.

BB. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings.

CC. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings.

DD. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings.

1.04 PERFORMANCE REQUIREMENTS

A. Rigging and overhead secondary suspension systems design requirements:
   1. Secondary means of support for elements, which are either suspended or hung overhead by a single attachment point.
   2. Supports shall be capable of supporting the structural loads without exceeding the allowable design working stress of the materials involved. The redundant support system is required for static and dynamic objects that are mechanically supported from a single point.
   3. This support system is required for interior and exterior elements in both the guest and employee areas.
   4. Complex items consisting of many parts shall have redundancy support for all objects that make up the whole.
      a. The secondary support system shall be capable of supporting the object should the main support fail.
   5. This support system applies to suspended overhead elements including, but not limited to:
      a. Hanging potted plants
      b. Suspended exhibits, signage and graphics
      c. Suspended props and themed elements
      d. Suspended mechanical and electrical elements; pendant lights, chandeliers, show and theatrical lighting, audio/video equipment, canopies, light bridges, light grids, and rigging of lighting equipment racks.
   6. Visual impact of the suspension system is a design issue and must be considered as a significant element in planning the systems. The intent is to make the system as invisible as

possible; however, the primary requirement is to meet the safety requirements to provide a fail-safe secondary support system.
    a. Where visible, the support system shall be painted to match the adjacent surfaces of the surrounding elements.
7. The secondary support shall not interfere with the function or adversely affect the object, which it is supporting.
8. All eyebolts, screw eyes and rings shall be forged seamless construction.
    a. Hooks and seamed eyebolts and rings may not be used.

B. Design Load
1. Design loads resulting from the dead loads, rated loads, cyclic dynamic loads, and wind loads must be adequately tied back to the structural load path of the primary structure.
    a. Loads of two (2) pounds or less may be attached to architectural materials if the material is adequate to support the load.
2. Required Minimum Safety Ratios: The safety ratio for specific installations shall meet the minimum load supporting capability of secondary suspension system to actual load ratios for the installed conditions as follows:

Static position	5:1	(No movement)
Minimal use, dynamic	8:1	(No more than 12 times per week)
Dynamic position	12:1	(Continual usage)

3. Lighting Pipe Racks Structural Performance: Provide rigging capable of withstanding the effects of the following design loads and the weight of stage curtains.
    a. Design Loads: Twenty pounds (20) per linear foot minimum or as noted on the drawings and scope of work.

C. Rigging and overhead secondary suspension system requirement does not apply to:
1. Building structure and architectural components.
2. Very light and soft objects having no sharp edges or points and of very low mass (e.g. cloth banners, flags, etc.) that would not cause personal injury if the object were to fall.

1.05 SUBMITTALS

A. Qualification Data
1. For fabricator.
2. For professional engineer.
3. For testing agency.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
2. Welded connections are required to be made in the shop prior to galvanizing.

C. Delegated-Design Submittal: Include structural analysis data for fabrications to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation and licensed by the authority having jurisdiction.

D. Mill Certificates: Signed by stainless-steel manufacturers, certifying the products furnished comply with requirements.

E. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

1.06 QUALITY ASSURANCE

A. Comply with provisions of the latest edition of the following documents, except where more stringent requirements are shown or specified:

1. American Institute of Steel Construction (AISC): 303 Code of Standard of Practice for Structural Steel Buildings and Bridges.
2. American Society of Civil Engineers (ASCE): Minimum Design Loads for Buildings and Other Structures.
3. American Society for Testing and Materials (ASTM): Metal fabrications;
    a. A653 (A653M) Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    b. A1008 (A1008M) Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
    c. B209, (B209M) Alloy 6061-T6, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
    d. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: A588 (A588M), Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi Minimum Yield Point, with Atmospheric Corrosion Resistance.
    e. A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
4. American Welding Society (AWS): Welding Sheet Steel in Structures.
5. Florida Building Code, 2010 Edition with local amendments.

B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1.M, “Structural Welding Code – Steel.”
2. AWS D1.2/D1.2.M, “Structural Welding Code – Aluminum.”
3. AWS D1.6/D1.6.M, “Structural Welding Code – Stainless Steel.”
4. Structural field welding and shop welding is subject to Special Inspection as required by the authority having jurisdiction.

C. Fabricator Qualifications: A firm experienced in producing metal fabrications 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. Professional Engineer Qualifications: Design members and connections under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the project's jurisdiction.

E. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."
3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

F. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

G. Coordinate installation of anchorages for metal fabrications.
1. 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.
2. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 METALS - GENERAL

A. Coordinate selection of metals and their standards as appropriate for application with Architect.

B. Steel Sections: ASTM A 36/A 36M, or as noted on drawings and scope of work.

C. Steel Tubing: ASTM A 500, Grade B cold-formed structural tubing.

D. Plates: ASTM A 283, ASTM A 276 - Type L, or as noted on drawings and scope of work.

E. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.

F. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, galvanized to ASTM A 153/A 153M where connecting galvanized components. Made in the USA only

G. Welding Materials: AWS D1.1; type required for materials being welded.

H. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

I. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 MATERIALS - STAINLESS STEEL

A. ASTM A276 Type 304 or ASTM A 276 Type 316L.

B. Bolts, Nuts, and Washers: ASTM A320 or as noted on drawings and scope of work. Made in the USA only.

2.03 SCHEDULE

A. Provide galvanized steel products unless noted otherwise on drawings and below.
   1. At exterior locations, provide Type 304 Stainless Steel.

2.04 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by continuous welds unless noted.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted.

G. Fabricate in a manner to eliminate distortion

H. Provide erection marks as required for field assembly that are not visible or easily removed if visible without damaging the finish.

I. Fabricate joints that will exclude water and provide weep holes or drainage where water can accumulate.

J. Eliminate the detrimental effects of thermal movement from fabrication and ambient temperatures which could cause buckling, opening of joints, overstressing components, failure of connections, and loss of waterproofing.

2.05 FINISHES - GENERAL

A. Shop Primers: Provide primers that comply with Section 099000 – Painting & Coating.

B. Galvanized Repair Paint: High-zinc-dust-content paint for re-galvanizing welds in steel complying with SSPC-Paint 20.

C. Prime paint all steel items or as noted on drawings and scope of work.
   1. Exceptions: Galvanize items to be embedded in concrete or masonry and items specified for other finish.
   2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
   1. Exteriors (SSPC Zone 113): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
   2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

E. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

F. Prime Painting: One coat.

G. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A 123/A 123M requirements.

H. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A 123/A 123M requirements.

2.06 FINISHES - ALUMINUM

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.

B. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.07 FINISHES - STAINLESS STEEL

A. Structural shapes annealed and pickled providing a 2B like finish or as noted on drawings and scope of work.

2.08 RIGGING AND OVERHEAD SECONDARY SUSPENSION SYSTEMS

A. Materials: Wire rope is the preferred material to use for the secondary suspension system.
   1. Wire rope shall meet MIL-W-83420D.
   2. Where no other paint color is specified (i.e.: match fixture) use black cable.

B. Normal installations shall use 7 x 19 preformed galvanized aircraft cable of the appropriate size to support the load.
   1. Installations subject to severe atmospheric or environmental conditions (salt water) shall use 7 x 19 stainless steel aircraft cable of the appropriate size to support the load.
   2. Wire Rope Rating: per From Mil Spec. MIL-W-83420D,

MINIMUM BREAKING STRENGTH IN POUNDS

Nominal Diameter	7 x 19 Galvanized	7 x 19 Stainless
1/16	480	480
3/32	1000	920
1/8	2000	1760
5/32	2800	2400
3/16	4200	3700

7/32	5600	5000
1/4	7000	6400
5/16	9800	9800
3/8	14400	12000
7/16	17600	16300
1/2	22800	22800
5/8	35000	35000
3/4	49600	49600

C. Termination of wire rope: Wire rope shall terminate in swag fitting or around thimble and attached with a cable clip, splice, or swag fitting. Swaged terminations are preferred over cable clamps.
   1. Thimbles shall be manufactured to meet or exceed Type 11 or Type III per Federal Specification FF-T-276b.
      a. When used with stainless steel aircraft cable, stainless steel thimbles shall be used and shall meet AN 100 Standards.
      b. Thimbles with appropriate sized grooves for the wire rope shall be used to attach the wire rope.
      c. Wire rope terminating in a loop around a thimble shall be attached by means of the appropriate number of u-bolt wire rope clips.

   2. Wire rope clips shall meet Federal Specification FF-C-450D, Type 1, Class 1, and single saddle with mating single u-bolt and heavy hexagon nuts with UNC 2-B threads.
      a. Saddles, bolts and clips shall be manufactured from forged carbon steel for sizes up to 2 inches, and from cast steel for sizes larger than 2 inches. Malleable wire rope clips shall not be used.
      b. All parts shall be zinc coated.
      c. Clips shall be legibly and permanently marked with size and manufacturer's identification.
      d. Wire rope cables shall be installed as recommended in the Wire Rope User's Manual, by the American Iron and Steel Institute.
      e. The exposed end of the rope shall be seized to prevent fraying.
      f. CABLE CLIP TABLE: per Rope User's Manual by the American Iron and Steel Institute,

CHP size (Inches)	Minimum number clips	Amount of rope to turn back	Torque in lbs. Ft.
1/8	2	3-1/4	4.5
3/16	2	3-1/4	7.5
1/4	2	4-3/4	15
5/16	2	5-1/4	30
3/8	2	6-1/2	45
7/16	2	7	65
1/2	2	11-1/2	65
9/16	3	12	95
5/8	3	12	95
3/4	4	18	130
7/8	4	19	225

   3. Swaged sleeves shall meet Military Standards MS 51884, Rev. C Swaging Sleeve - Wire Rope. These sleeves are the preferred means of fastening wire rope.
      a. Zinc coated copper sleeves shall be used for carbon steel wire rope. Tin plated copper or stainless steel sleeves shall be used for stainless steel wire rope.
      b. Only oval sleeves sized for the diameter of the wire rope shall be used and must be installed in accordance with manufacturer's instruction. Crimping will be pre-formed with the tool specifically manufactured for the compression sleeve used. Ideally a

hydraulically activated tool will be used. Check the first and every 50th crimp with a "go-type" gauge of the appropriate size for the fitting.

c. Eye splices shall hold 100% of the rated strength of 7 x 19 wire rope when swaged fittings are properly installed in accordance with manufacturer's instructions. A proof test of the application is recommended.

d. Install the manufacturer specified number of compression sleeves plus one. The additional unit will be placed at the end of the fitting, within 1/8 inch of the end of the wire rope tail.

e. COMPRESSION TYPE OVAL SLEEVES TABLE:

Cable Size	Number of Presses*
1/16	1
3/32	1
1/8	2
5/32	2
3/16	2
7/32	2
1 A	3
5/16	3
3/8	2
7/16	2
1/2	2
5/8	3

*Depends upon the selection of proper tool as specified by the manufacturer.

4. Swaged cable terminations should be factory installed on the ends of wire rope.
   a. Swaged end fittings may include eye rings, fork with round pin and cotter pin, pin eye, standard sleeve or oval eye manufactured as seamless drop forged fittings.
   b. Threaded sleeves and threaded studs may be used.
      1) Hooks and seamed eyebolts and rings may not be used.
5. Additional fitting designs may be available or may be custom manufactured to meet the specific needs but must have a sure, firm closure and must be proof tested.
6. Fittings manufactured from stainless steel for use in wet, damp or corrosive atmospheres may be used.
7. Fittings shall develop holding strengths equal to the wire rope to which they are attached.

PART 3 - EXECUTION

3.01 INSTALLING RIGGING AND OVERHEAD SECONDARY SUSPENSION SYSTEMS

A. Hanging wire rope:
   1. Fleet angle shall not exceed 1.50 either side of centerline.
   2. When reeving sheaves, as few bends as possible shall be planned. Reverse bends shall be avoided whenever possible. If reverse bends are required, they shall be spaced as far apart as possible.
   3. Sheaves and drums are to be of the proper size, and will be free running. All sheaves and drums will be grooved with proper size groove for the cable to be used in the application. The diameter of the drum or sleeve ratio is determined by the D/d ratio as suggested by the Wire Rope Manufactures.
   4. D/d RATIOS (CABLE DIAMETER TO SHEAVE DIAMETER) TABLE

Suggested D/d ratios:	
For 7 x 19 Galvanized Aircraft	35 x d (cable)
For 7 x 19 Stainless Steel Aircraft	45 x d (cable)

5. When unreeling wire rope, the reel shall be mounted vertically on a shaft and revolved as the rope is pulled straight ahead, keeping the wire rope taught to prevent it from loosening on the reel. The cable must not be walked around the reel.
6. When uncoiling wire rope the coil shall be walked along the ground so the rope lies straight. The cable must not be pulled out from the coil.

B. Thin wire shall be used to provide a secondary attachment to suspended objects with a single attachment method.
   1. Provide all fittings and hardware for a complete installation.
   2. Coordinate attachment points for all electrical fixtures or acoustical devices with the manufacturer.

3.02 ADJUSTING AND CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Section "Paints and Coatings."

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

SECTION 055000

METAL FABRICATIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Shop fabricated steel and stainless steel items including:
   1. Miscellaneous metal fabrications.
   2. Steel shapes.
   3. Aluminum shapes.
   4. Stainless steel shapes.
   5. Galvanized steel shapes.
   6. Pipe bollards.
   7. Fall Protection Devices – Permanent Installations.
   8. Trench Grates.

1.02 RELATED SECTIONS

A. Section 010300 – Summary of Project: Extents of corrosive environment.

B. Section 033000 - Cast-in-Place Concrete: Placement of metal fabrications in concrete.

C. Section 034500 - Precast Architectural Concrete: Placement of metal fabrications in precast concrete.

D. Section 051200 – Structural Steel: Structural steel column anchor bolts.

E. Section 054500 - Secondary Metal Support Assemblies: secondary bracing of overhead hanging elements.

F. Section 055213 – Metal Pipe & Tube Railings.

G. Section 099000 – Painting and Coating: Paint finish.

H. Section 099600 – High Performance Coatings: Paint finish.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ANSI A14.3 - American National Standard for Ladders -- Fixed -- Safety Requirements.

C. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.

D. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

E. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

F. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

G. ASTM A 276 - Specifications for Stainless Steel Bars and Shapes.

H. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

I. ASTM A 320 - Specifications for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.

J. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

K. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

L. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

M. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.

N. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings.

O. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings.

1.04 SUBMITTALS

A. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
   1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths. All welded connections are required to be made in the shop prior to galvanizing.
   2. Clearly identify all field work and connections. All field connections to be compression or bolted connections.

B. Structural Calculations: Provide full engineering calculations for elements required by the Authority Having Jurisdiction to be structurally designed.
   1. Calculations shall be signed and sealed by a qualified structural engineer registered in the state in which the project is located.

C. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

D. Written certification by fabricator that the components are hot-dip galvanized as specified.

1.05 QUALITY ASSURANCE

A. Design members and connections under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the project's jurisdiction.

B. Fabricator Qualifications: A firm experienced in producing metal fabrications 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. All materials within the limits of the Corrosive Environment are to be of non-corrosive material.

1.06 PROJECT CONDITIONS

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.07 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. 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

2.01 METALS - GENERAL

A. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

B. Components to be shop fabricated to extent possible. No field welding is permitted. All field connections to be compression or bolted connections.

2.02 MATERIALS - STEEL

A. Steel Sections: ASTM A 36/A 36M, or as noted on drawings and scope of work.

B. Steel Tubing: ASTM A 500, Grade B cold-formed structural tubing.

C. Plates: ASTM A 283, ASTM A 276 - Type L, or as noted on drawings and scope of work.

D. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.

E. Slotted Channel Framing: Cold formed metal channels with flange edges returned toward web and with 9/16-inch wide slotted holes in webs at 2 inches o.c
   1. Width of Channels: 1-5/8 inches.
   2. Depth of Channels: 1-5/8 inches.
   3. Metal and Thickness: Galvanized steel complying with ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating; 0.108-inch nominal thickness.

F. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

G. Bolts, Nuts, and Washers: ASTM A 325, galvanized to ASTM A 153/A 153M where connecting galvanized components. Made in the USA only

H. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

I. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.03 MATERIALS- STAINLESS STEEL

A. ASTM A276 Type 304 or ASTM A 276 - Type 316L when near salt water or as noted on drawings and scope of work.

B. Bolts, Nuts, and Washers: ASTM A320 or as noted on drawings and scope of work. Made in the USA only.

2.04 FABRICATION

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. 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.
   1. All field splicing or connection to be compression or bolted connections.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by continuous welds unless noted.
   1. Field welds are not permitted.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius of approximately 1/32 inch without causing grain separation or otherwise impairing work.

E. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat head (countersunk) screws or bolts. Locate joints where least conspicuous.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted.

G. Fabricate in a manner to eliminate distortion and develop strength and corrosion resistance of base materials.

H. Provide erection marks as required for field assembly that are not visible or easily removed if visible without damaging the finish.

I. Fabricate joints that will exclude water and provide weep holes or drainage where water can accumulate.

J. Eliminate the detrimental effects of thermal movement from fabrication and ambient temperatures which could cause buckling, opening of joints, overstressing components, failure of connections, and loss of waterproofing.

K. Obtain fusion without undercut or overlap.

L. Remove welding flux immediately.

M. 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.

N. Remove sharp or rough areas on exposed traffic surfaces.

2.05 FABRICATED ITEMS

A. Ladders: Steel; in compliance with ANSI A14.3; with mounting brackets and attachments; prime paint finish or as noted on drawings or scope of work.
   1. Side Rails: 3/8 x 2 inches (9 x 50 mm) members spaced at 20 inches (500 mm).
   2. Rungs: one-inch (25 mm) diameter solid round bar spaced 12 inches (300 mm) on center with abrasive non-slip surface as supplied by Mebac; IKG Borden. Material finish to match ladder.
   3. Space rungs 7 inches (175 mm) from wall surface.

B. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; minimum schedule 40 with galvanized finish.
   1. Provide 1/8” yellow HPDE bollard cover with bullet ends over each steel bollard. Provide neoprene adhesive tape.

C. Joist and Joist Hangers: Strap anchors, fabricated with 18 gage minimum steel; galvanized finish.

2.06 MISCELLANEOUS FRAMING AND SUPPORTS

A. Provide steel framing and supports indicated and as necessary to complete the Work.

B. Fabricate units from structural-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 retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
   1. Fabricate units from slotted channel framing where indicated.

2. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors 1-1/4 inches (32 mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long at 24 inches (600 mm) o.c., unless otherwise indicated.
3. Furnish inserts if units must be installed after concrete is placed.

C. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
1. Provide bearing plates welded to beams where indicated.
2. Drill girders and plates for field-bolted connections where indicated.
3. Where wood nailers are attached to girders with bolts or lag screws, drill holes at 24 inches (600 mm) o.c.

D. Galvanize miscellaneous framing and supports unless noted otherwise.

2.07 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from structural-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. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches (150 mm) from each end, 6 inches (150 mm) from comers, and 24 inches (600 mm) o.c., unless otherwise indicated.

C. Galvanize miscellaneous steel trim unless noted otherwise.

2.08 FINISHES - STEEL

A. All steel to be G90 galvanized by the hot dip process per ASTM A 123/A 123M requirements.
1. Galvanize assemblies after fabrication to the fullest extent possible.

B. Provide zinc rich primer and finish paint at any permitted field welding. Refer to Section 099000.

2.09 FINISHES - STAINLESS STEEL

A. Structural shapes annealed and pickled providing a 2B like finish unless noted otherwise.

B. Handrail and guardrail shall have a number 4 polished finish (120 to 150 grit) unless noted otherwise.

2.10 FASTENERS

A. General: Provide Type 304 or 316L stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36.

D. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).

E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

F. Forged Eye-Bolts: Drop forged steel ASTM C 1023 with a galvanized finish. Threaded bolts or lag bolts as manufactured by Chicago Hardware.

G. Plain Washers: Round, carbon steel, ASME B18.22.1 (ASME B18.22M).

H. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1 (ASME B18.21.2M).

I. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.

J. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as needed.

2.11 GATE ACCESSORIES

A. Hardware: As noted on Drawings.
   1. Metal: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations.
   2. Hinges: Daro Series 610 barrel hinges.
   3. Slide Bolt: Action latch, to accommodate Owner provided lock.
   4. Hasp: Keylocking type, Stanley 921, 4 ½ “, zinc plated.
   5. Cane Bolt: Stainless steel, spring-loaded.
      a. Length: Sized for site conditions. Field verify that gate and cane bolt lift higher than finished pavement elevation along full swing of gates. Cane bolt shall not drag on finished surface.
   6. Wheel: Solid rubber tire with PVC hub, Harbor Freight #40598.

2.12 GROUT

A. Nonshrink, Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.

2.13 FABRICATION TOLERANCES

A. Squareness: 1/16 inch (1.5 mm) maximum difference in diagonal measurements.

B. Maximum Offset Between Faces: 1/16 inch (1.5 mm).

C. Maximum Misalignment of Adjacent Members: 1/16 inch (1.5 mm).

D. Maximum Bow: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

E. Maximum Deviation From Plane: 1/16 inch (1.5 mm) in 48 inches (1.2 m).

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

A. Supply setting templates to the appropriate entities for steel items required to be cast into concrete.

3.03 INSTALLATION

A. 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.

B. Install items plumb and level, accurately fitted, free from distortion or defects.

C. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

D. Obtain approval prior to site cutting or making adjustments not scheduled.
   1. Any field welding required is to be approved by Owner’s representative before welding is to commence.
   2. Any approved field welds to be in accordance with AWS D1.1/D1.1M.
   3. Clean and strip primed steel items to bare metal where site welding is required.

4. Fix exposed connections accurately together to form hairline joints.
5. Materials may be rejected if galvanized coating is damaged in any way.

E. After erection, prime welds, abrasions, and repair other finish defects to restore finishes to their designed condition.

3.04 INSTALLATION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/8 inch (3.0 mm).

C. Maximum Out-of-Position: 1/8 inch (3.0 mm).

3.05 ADJUSTING AND CLEANING

A. Obtain approval prior to any site repairs.

B. Material may be rejected if galvanized coating is damaged in any way.

C. Stainless Steel Surfaces: Clean welds and bolted connections. Burn marks from welding will not be acceptable.

END OF SECTION

SECTION 055100

METAL STAIRS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Structural steel stair framing and supports.

B. Checkered plate stair treads and landings.

1.02 RELATED SECTIONS

A. Section 010300 – Summary of Project: Extents of corrosive environment.

B. Section 055000 - Metal Fabrications: Stair nosings, miscellaneous attachments.

C. Section 055213 – Metal Pipe & Tube Railings: Metal handrails and balusters other than specified in this section.

D. Section 099000 - Paints and Coatings: Paint finish.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.

C. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

D. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

E. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

F. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

G. ASTM A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

H. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

I. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

J. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

K. ASTM A 786/A 786M - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.

L. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society.

M. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.

N. NAAMM AMP 510 - Metal Stairs Manual; The National Association of Architectural Metal Manufacturers.

O. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings.

P. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings.

1.04 DESIGN REQUIREMENTS

A. Design and fabricate stair assembly to support a minimum uniform live load of 100 lb/sq ft (4.7 kPa) and a concentrated load of 300 lb (14.4 kg) with deflection of stringer or landing framing not to exceed 1/360 of span unless noted on the drawings or scope of work.

B. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of applicable local codes.

1.05 SUBMITTALS

A. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
   1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths. Welded connections are required to be made in the shop prior to galvanizing.
   2. Clearly identify all field work and connections. All field connections to be compression or bolted connections.
   3. Shop drawings to be signed and sealed by a qualified structural engineering registered in the project's jurisdiction.

B. Structural Calculations: Provide full engineering calculations for elements required by this section to be structurally designed by the contractor.
   1. Calculations shall be signed and sealed by a qualified structural engineer registered in the state in which the project is located.

C. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

D. Written certification by fabricator that the components are hot-dip galvanized as specified.

1.06 QUALITY ASSURANCE

A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the state in which the project is located, or personnel under direct supervision of such an engineer.

PART 2 - PRODUCTS

2.01 METAL STAIRS - GENERAL

A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
   1. Regulatory Requirements: Provide stairs and railings complying with the most stringent requirements of local, state, and federal regulations; where requirements of the contract documents exceed those of regulations, comply with the contract documents.
   2. Structural Design: Provide complete stair and railing assemblies complying with the applicable local code.
   3. Dimensions: As indicated on drawings.
   4. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
      a. All field splicing or connections to be via mechanical connections. Field welding is not permitted.
   5. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
   6. Separate dissimilar metals using paint or permanent tape.

B. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.

C. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 MATERIALS

A. Steel Sections: ASTM A 36/A 36M.

B. Steel Tubing: ASTM A 500, Grade B cold-formed structural tubing.

C. Steel Plates: ASTM A 283.

D. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.

E. Ungalvanized Steel Sheet: ASTM A 1008/A 1008M, Designation SS, Grade 33, Type 1.

F. Galvanized Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS) Grade 33/230 with G90/Z275 coating.

G. Checkered Plate: ASTM A 786/A 786M, rolled steel floor plate; pattern no. 2.

H. Steel Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, galvanized to ASTM A 153/A 153M where connecting galvanized components.

I. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; consistent with design of stair structure.

J. Welding Materials: AWS D1.1; type required for materials being welded.

K. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

L. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.03 FABRICATION - GENERAL

A. Fit and shop assemble components in largest practical sections.
   1. All field splicing or connections to be via mechanical connections.

B. Fabricate components with joints tightly fitted and secured.

C. Continuously seal joined pieces by continuous welds.
   1. Field welds are not permitted.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

G. Fabricate components accurately for anchorage to each other and to building structure.

2.04 FABRICATION - CHECKERED PLATE STAIRS

A. Form treads with minimum 12 gauge checkered steel plate; galvanized finish. Weld to stringer support clips. Bend nosing to a 1 inch radius and return down 1/2 inch (13 mm) .

B. Form stringers with rolled steel channels, of minimum of 10 inches (250 mm) deep, unless noted otherwise; galvanized finish.

C. Form landings with minimum 12 gauge checkered steel plate; galvanized finish. Reinforced underside with angles to attain design load requirements.

2.05 FINISHING

A. All steel to be G90 galvanized by the hot dip process per ASTM A 123/A 123M requirements.
   1. Galvanize assemblies after fabrication to the fullest extent possible.

PART 3 - EXECUTION

3.01 EXAMINATION

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

B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

C. Do not prime surfaces in direct contact with concrete or where field welding is required.

D. At locations with ungalvanized steel that is to receive paint, prime with one coat of zinc rich primer.

3.02 PREPARATION

A. When field welding is required, clean and strip primed steel items to bare metal.

B. Supply items required to be cast into concrete and embedded in masonry with setting templates.

3.03 INSTALLATION

A. Do not weld, cut, or abrade surfaces of exterior units that have been hot dipped galvanized after fabrication and are for bolted or screwed field connections.

B. Install components plumb and level, accurately fitted, free from distortion or defects.

C. Position Inclined Metal Ladder Stairs with top tread at same elevation as upper finished floor surface.

D. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.

E. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

F. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1.

G. Field bolt and weld to match shop bolting and welding. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

H. Obtain approval prior to site cutting or creating adjustments not scheduled.
   1. Any field welding required is to be approved by Owner's representative before welding is to commence.
   2. Any approved field welds to be in accordance with AWS D1.1/D1.1M.
   3. Clean and strip primed steel items to bare metal where site welding is required.
   4. Fit exposed connections accurately together to form hairline joints.
   5. Material may be rejected if galvanized coating is damaged in any way.

I. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 INSTALLATION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

3.05 ADJUSTING AND CLEANING

A. Obtain approval prior to any site repairs.

B. Material may be rejected if galvanized coating is damaged in any way.

END OF SECTION

SECTION 055213

METAL PIPE & TUBE RAILINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wall mounted handrails.

B. Stair railings and guardrails.

C. Free-standing railings at steps.

D. Balcony railings and guardrails.

E. Queue Railing.

1.02 RELATED SECTIONS

A. Section 010400 - Accessibility for Persons with Disabilities: Dimensional requirements for compliance with applicable accessibility regulations.

B. Section 033000 - Cast-in-Place Concrete: Placement of anchors in concrete.

C. Section 042000 - Reinforced Unit Masonry Assemblies: Placement of anchors in masonry.

D. Section 055100 - Metal Stairs: Coordination of handrails.

E. Section 062000 - Finish Carpentry: Wood handrail.

F. Section 092116 - Gypsum Board Assemblies: Placement of backing plates in stud wall construction.

G. Section 099000 - Painting and Coating: Paint finish.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association.

C. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.

D. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.

E. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

F. ASTM B 211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

G. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

H. ASTM B 241/B 241M - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.

I. ASTM B 429/B 429M - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

J. ASTM B 483/B 483M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Tubes and Pipe for General Purpose Applications.

K. ASTM E 935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.

L. ASTM E 985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.

1.04 SUBMITTALS

A. Product Data: Manufacturer's specifications and installation instructions for all components of each product type specified.

B. Shop Drawings: Indicate profiles, finishes, sizes, connection attachments, size and type of fasteners, and welds.
   1. Include dimensions of clear openings through railings.
   2. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths. Welded connections are required to be made in the shop prior to galvanizing.
   3. Include the design engineer's stamp or seal on each sheet of shop drawings.
   4. Clearly identify all field work and connections. All field connections to be compression or bolted connections.

C. Samples: Submit two, 6 inch long samples of handrail. Submit two samples of elbow, wall bracket, and end stop.

D. Written certification by fabricator that the components are hot-dip galvanized as specified.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer and craftsmen having resources to provide consistent quality in appearance and physical properties, without delaying the work.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver components in protective packaging. Inspect materials to ensure that specified products have been received.

B. Store components to avoid damage from abrasion and other construction activities.

PART 2 - PRODUCTS

2.01 RAILINGS - GENERAL REQUIREMENTS

A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E 985 and applicable local code.

B. Design shall be engineered by a professional engineer registered in the project's jurisdiction.

C. Design railing assembly, wall rails, and attachments to resist lateral force of 200 lbs at any point without damage or permanent set. Test in accordance with ASTM E 935.

D. Allow for expansion and contraction of members and building movement without damage to connections or members.

E. Dimensions: As indicated below, unless noted otherwise on drawings.
   1. Top Rails and Wall Rails: 1-1/2 inches (38 mm) diameter, round.
   2. Intermediate Rails: 1-1/2 inches (38 mm) diameter, round.
   3. Posts: 1-1/2 inches (38 mm) diameter, round.

F. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
   1. For anchorage to concrete, provide inserts to be cast into concrete, for bolting anchors.
   2. For anchorage to masonry, provide brackets to be embedded in masonry, for bolting anchors.

3. For anchorage to stud walls, provide backing plates, for bolting anchors.
4. Posts: Provide adjustable flanged brackets.

G. Provide welding fittings to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.
   1. Field welding is not permitted.

2.02 STEEL MATERIALS

A. Steel Tube: ASTM A 500, Grade B cold-formed structural tubing.

B. Steel Pipe: ASTM A 53/A 53M, Grade B Schedule 40, galvanized finish to receive field paint finish.

C. Non-Weld Mechanical Fittings: Slip-on, galvanized malleable iron castings, for Schedule 40 pipe, with flush setscrews for tightening by standard hex wrench, no bolts or screw fasteners.

D. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.
   1. Field welding is not permitted.

E. Exposed Fasteners: No exposed bolts or screws.

F. Straight Splice Connectors: Steel concealed spigots.

G. Finish: All steel to be G90 galvanized by the hot dip process per ASTM A 123/A 123M requirements.
   1. Galvanize assemblies after fabrication to the fullest extent.

2.03 STAINLESS STEEL MATERIALS

A. Type 304 pipe complying with ASTM A 312.

B. Finish: Number 4 polished finish (120 to 150 grit) unless noted otherwise.

2.04 FABRICATION

A. 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.

B. Accurately form components to suit specific project conditions and for proper connection to building structure.

C. Fit and shop assemble components in largest practical sizes for delivery to site.

D. Shop Welded Joints:
   1. Exterior Components: Continuously seal joined pieces by continuous welds. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
   2. Interior Components: Continuously seal joined pieces by continuous welds.
   3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Obtain approval prior to site cutting or making adjustments not scheduled.
   1. Any field welding required is to be approved by Owner’s representative before welding is to commence.
   2. Any approved field welds to be in accordance with AWS D1.1/D1.1M.
   3. Fit exposed connections accurately together to form hairline joints

F. Fabricate components with joints tightly fitted and secured.

G. Smooth exposed edges and projections that would be uncomfortable to the touch.

2.05 FASTENERS

A. Use fasteners suitable for the material being fastened and for the type of connection required.

B. All fasteners to be non-corrosive.

2.06 GATE ACCESSORIES

A. Hardware
   1. Material and finish to match adjacent railing
   2. Hinges: self-closing, concealed hinge. Closing force shall be compliant with applicable codes
   3. Gate strike plate shall be furnished with a rubber pad to allow cushioned close
   4. Smooth exposed edges and projections that may come in contact with occupants

PART 3 - EXECUTION

3.01 EXAMINATION

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

B. Notify contractor in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected.
   1. Starting work indicates acceptance of conditions.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply items required to be cast into concrete, embedded in masonry, or placed in partitions with setting templates, for installation as work of other sections.

C. Apply one coat of bituminous paint to concealed aluminum surfaces that will be in contact with cementitious or dissimilar materials.

D. Priming: Apply primer in shop immediately after preparation:
   1. Apply extra coat to corners, weld, edges, and fasteners.
   2. Shop prime all steel members of fabrications indicated to be factory-primed for painting.
      a. Exceptions:
         1) Surfaces to be field welded.
         2) Surfaces in direct contact bond with concrete.

3.03 INSTALLATION

A. 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.

B. Install in accordance with manufacturer's instructions.

C. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.

D. Anchor railings securely to structure.

E. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

F. Avoid field welding, if necessary, weld joints as indicated.
   1. Weld in accordance with AWS code.
   2. Fit joints tightly.
   3. Exposed welds: Grind flush and smooth.
   4. Coat with rust inhibitive welders primer before finish coating.

G. For posts mounted into concrete floor pockets, completely fill pocket and slope top away from railing.
   1. Standing water at the base of railing posts is not acceptable.

3.04 TOLERANCES

A. Maximum Variation From Plumb: 1/8 inch (3 mm).

B. Maximum Offset From True Alignment: 1/8" inch (3 mm).

C. Maximum Out-of-Position: 1/8" inch (3 mm).

3.05 ADJUSTING AND CLEANING

A. Obtain approval prior to any site repairs.

B. Railing may be rejected if galvanized coating is damaged in any way.

END OF SECTION

SECTION 055300

METAL GRATINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Formed metal floor and mezzanine gratings.

B. Flat surface floor plating.

C. Perimeter closure.

1.02 RELATED SECTIONS

A. Section 033000 - Concrete: Framed concrete opening.

B. Section 055000 - Metal Fabrications: Open framing.

C. Section 099000 - Paints and Coatings: Field paint finish.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.

C. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

D. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

E. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

F. ASTM A 786/A 786M - Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.

G. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

H. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society.

I. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society.

J. NAAMM MBG 531 - Metal Bar Grating Manual; The National Association of Architectural Metal Manufacturers (ANSI/NAAMM MBG 531).

K. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings.

1.04 PERFORMANCE REQUIREMENTS

A. Conform to applicable code for loading requirements.

B. Design Live (Pedestrian) Load: Uniform load of 200 lb/sq ft (9.4 kPa) minimum; concentrated load of 300 lbs (1330 N).

C. Design Live (Light Vehicle) Load: Uniform load of 500 lb/sq ft (23.9 kPa) minimum; concentrated load of 2000 lbs (4440 N).

D. Maximum Allowable Deflection Under Live Load: 1/240.

E. Maximum Spacing Between Bars: To restrict pedestrian shoe heels.

1.05 SUBMITTALS

A. Product Data: Provide span and deflection tables.

B. Shop Drawings: Indicate details of component supports, openings, perimeter construction details, and tolerances.
   1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

C. Samples: Submit samples illustrating surface finish, color, and texture.

D. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design gratings and plates under direct supervision of a licensed Professional Engineer experienced in design of this type of work and licensed in project's jurisdiction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel Floor Plate: ASTM A 786/A 786M; pattern as indicated.

B. Steel Framing: ASTM A 36/A 36M shapes, unfinished.
   1. Provide stainless steel if in areas containing salt water.

C. Cross Bars: ASTM B 211 solid bars..

D. Welding Materials: AWS D1.1; type required for materials being welded.

E. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 ACCESSORIES

A. Fasteners and Saddle Clips: Galvanized steel.
   1. Provide stainless steel if plate is within areas containing salt water.

B. Perimeter Closure: Of same material as grating.

2.03 FABRICATION

A. Grating Type: NAAMM MBG 531, Welded Type.

B. Mechanically clinch joints of intersecting metal sections.

C. Fabricate support framing for openings.

D. Top Surface: Non-slip.

E. Bearing and Cross Bar: As required by design to meet applicable loads.

F. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. 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.
   1. All field splicing or connections to be via mechanical connections.
   2. Field welding of components exposed to salt water or exterior elements shall not be permitted.

2.04 FINISHES

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. All steel to be G90 galvanized by the hot dip process per ASTM A 123/A 123M requirements.
   1. Galvanize assemblies after fabrication to the fullest extent.
   2. All galvanized surfaces exposed within guest view are to be painted with color selected by Architect.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that opening sizes and dimensional tolerances are acceptable.

B. Verify that supports are correctly positioned.

3.02 INSTALLATION

A. Install components in accordance with manufacturer's instructions.

B. Place frames in correct position, plumb and level.

C. 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.

D. Set perimeter closure flush with top of grating and surrounding construction.

E. Secure to prevent movement.

END OF SECTION

SECTION 061000

ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Structural dimension lumber framing.

B. Non-structural dimension lumber framing.

C. Rough opening framing for doors, windows, and roof openings.

D. Sheathing.

E. Wood Furring.

F. Wood Sleepers.

G. Underlayment.

H. Building Wrap.

I. Roofing nailers.

J. Preservative treated wood materials.

K. Fire retardant treated wood materials.

L. Miscellaneous framing and sheathing.

M. Communications and electrical room mounting boards.

N. Concealed wood blocking, nailers, and supports.

O. Miscellaneous wood nailers, furring, and grounds.

P. Water-resistive barrier over wall sheathing.

1.02 RELATED SECTIONS

A. Section 051200 - Structural Steel: Prefabricated beams and columns for support of wood framing.

B. Section 055000 - Metal Fabrications: Miscellaneous steel connectors and support angles for wood framing.

C. Section 061756 – Shop-Fabricated Wood Trusses.

D. Section 072500 - Weather Barriers: Water-resistive and air barriers over sheathing.

E. Section 076200 - Sheet Metal Flashing and Trim: Flashing, trim, gutters and downspouts.

F. Section 092116 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ANSI A208.1 - American National Standard for Particleboard.

C. AFPA T10 - WFCM: Wood Frame Construction Manual for One- and Two-Family Dwellings; American Forest and Paper Association.

D. APA PRP-108/ APA PRP-108,Form B455 - Performance Standards and Qualification Policy for Structural-Use Panels.

E. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

F. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

G. ASTM C 208 - Standard Specification for Cellulosic Fiber Insulating Board.

H. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

I. ASTM C 1177/C 1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.

J. ASTM C 1396/C 1396M - Standard Specification for Gypsum Board.

K. ASTM D 2898 - Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.

L. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

M. AWPA C2 - Lumber, Timber, Bridge Ties and Mine Ties -- Preservative Treatment by Pressure Processes; American Wood-Preservers' Association.

N. AWPA C9 - Plywood -- Preservative Treatment by Pressure Processes; American Wood-Preservers' Association.

O. AWPA C20 - Structural Lumber -- Fire Retardant Treatment by Pressure Processes; American Wood-Preservers' Association.

P. AWPA C27 - Plywood -- Fire-Retardant Treatment by Pressure Processes; American Wood-Preservers' Association.

Q. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood-Preservers' Association.

R. ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers; ICC Evaluation Service, Inc.

S. PS 1 - Structural Plywood.

T. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce).

U. RIS (GR) - Standard Specifications for Grades of California Redwood Lumber; Redwood Inspection Service.

V. SPIB (GR) - Grading Rules; Southern Pine Inspection Bureau, Inc.

W. WCLB (GR) - Standard Grading Rules for West Coast Lumber No. 17; West Coast Lumber Inspection Bureau.

X. WWPA G-5 - Western Lumber Grading Rules; Western Wood Products Association.

1.04 SUBMITTALS

A. Product Data: Provide technical data on insulated sheathing, wood preservative materials, application instructions, and fire retardant treating material. Include treating plant's instructions for use, including storage, cutting and finishing.

B. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

C. Material Certificates: For dimension lumber specified by minimum allowable unit stress, submit:
   1. Statement of species and grade selected for each application.
   2. Grading agency's grading rules showing allowable design values accepted by the Board of Review of American Lumber Standards Committee.

3. Pressure preservative treatment: Treating plant's certification of compliance with specified standards and stating process employed and preservative retention values.
    a. Treatment for above-ground use: Certification of moisture content being as specified.
    b. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
4. For composite wood products, documentation indicating that product contains no urea formaldehyde.

1.05 QUALITY ASSURANCE

A. Source Limitations for Engineered Wood Products: Obtain each type of engineered wood product through one source from a single manufacturer.

B. Grade Stamps for Concealed Lumber: Each piece of lumber, applied by inspection agency and showing compliance with each specified requirement.

C. Construction Panels: Comply with NBS PS 1 where veneer plywood is specified; comply with APA PRP-108 where APA rated panels are specified; bearing APA trademark showing compliance with each specified requirement.

D. Certified Wood: Materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
    1. Dimension lumber framing.
    2. Timber.
    3. Laminated veneer lumber.
    4. Parallel-strand lumber.
    5. Prefabricated wood I-joists.
    6. Miscellaneous lumber.

E. Referenced Standards:
    1. If references herein to industry standards that do not include a date, the following dates shall be assigned to those references. The order of the list indicates the order of precedence:
        a. Date assigned by the specifications.
        b. Date required by applicable codes/regulations.
        c. Date of standard and/or product literature as published at time of bid opening date.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation. Provide air circulation around stacks and under coverings.

B. Remove from the site any wood products that have been subjected to moisture or that do not comply with the specified moisture requirements.

C. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
    1. Species: Douglas Fir-Larch or Southern Pine, unless otherwise indicated.
    2. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review

3. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
4. Lumber of other species or grades is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
    a. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
    b. Provide dressed lumber, S4S, unless otherwise indicated.

2.02 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: In accordance with AWPA T1.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency, if allowed by authorities having jurisdiction.
1. In drying process, prevent “stick marks” on exposed faces.

E. Application: Treat items indicated on Drawings, and the following:
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.
6. Wood sheathing resting on concrete foundations and less than 8 inches above finish grade.

2.03 FIRE-RETARDANT-TREATED MATERIALS

A. General: Comply with performance requirements in AWPA T1.
1. Use Exterior type for exterior locations and where indicated.
2. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
3. Use Interior Type A, unless otherwise indicated

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
1. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

C. Application: Treat items indicated, required to meet the fire resistance rating of wall or floor structure as noted on the drawings and the following:
1. All locations required by code of authorities having jurisdiction.

2. Framing for raised platforms.
3. Concealed blocking.
4. Plywood backing panels.

D. Lumber fabricated from old growth timber is not permitted.

2.04 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

A. Lumber Species: Southern Pine or Douglas-Fir Larch at No. 2 grade, unless specified otherwise, as defined by the following agencies:
1. Grading Agency: Southern Pine Inspection Bureau, Inc. (SPIB).
2. Grading Agency: West Coast Lumber Inspection Bureau (WCLB).

B. Sizes: Nominal sizes as indicated on drawings, S4S.

C. Moisture Content: S-dry or MC19.

D. Stud Framing (2 by 2 through 2 by 6 (50 by 50 mm through 50 by 150 mm)):
1. Species: Any allowed under referenced grading rules.
2. Grade: No. 2.

E. Joist, Rafter, and Small Beam Framing (2 by 6 through 4 by 16 (50 by 150 mm through 100 by 400 mm)):
1. Species: Any allowed under grading rules.
2. Grade: Machine stress-rated dimension lumber with a grade of not less than as required by structural drawings.

F. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
1. Lumber: S4S, No. 2 or Standard Grade.
2. Boards: Standard or No. 3.

2.05 EXPOSED DIMENSION LUMBER

A. Lumber Species: Southern Pine or Douglas-Fir Larch at No. 2 grade, unless specified otherwise, as defined by the following agencies:
1. Submit manufacturer's certificate that products meet or exceed specified requirements, in lieu of grade stamping.
2. Grading Agency: Southern Pine Inspection Bureau, Inc. (SPIB).
3. Grading Agency: West Coast Lumber Inspection Bureau (WCLB).

B. Sizes: Nominal sizes as indicated on drawings, S4S.

C. Moisture Content: S-dry or MC19.

D. Stud Framing (2 by 2 through 2 by 6 (50 by 50 through 50 by 150 mm)):
1. Species: Any allowed under referenced grading rules.
2. Grade: No. 2.

E. Joist, Rafter, and Small Beam Framing (2 by 6 through 4 by 16 (50 by 150 through 100 by 400 mm)):
1. Species and Grades: Any allowed under grading rules.
2. Grade: Machine stress-rated dimension lumber with a grade of not less than as required by structural drawings.

2.06 EXPOSED BOARDS

A. Submit manufacturer's certificate that products meet or exceed specified requirements, in lieu of grade stamping.

B. Moisture Content: Kiln-dry (15 percent maximum).

C. Surfacing: S4S.

D. Species: Douglas Fir or Southern Pine.

E. Grade: No. 2, 2 Common, or Construction.

2.07 CONSTRUCTION PANELS

A. Subfloor/Underlayment Combination: APA PRP-108, Rated Sturd-I-Floor.
   1. Exposure Class: Exterior.
   2. Span Rating: 16 inches (406 mm).
   3. Thickness: 3/4 inches (19 mm), nominal.
   4. Edges: Tongue and groove.

B. Roof Sheathing: APA PRP-108/APA PRPR-108, Form B455, Structural I Rated Sheathing, Exterior Exposure Class, and as follows:
   1. Span Rating: 24/0 (610/0).
   2. Thickness: 1/2 inch (13 mm), nominal.

C. Wall Sheathing: APA PRP-108/APA PRP-108, Form B455 Structural I Rated Sheathing, Exterior Exposure Class, and as follows:
   1. Span Rating: 24/0 (610/0).
   2. Thickness: 1/2 inch (13 mm), nominal.

D. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch (19 mm) thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E 84.

E. Other Applications:
   1. Plywood Concealed From View But Located Within Exterior Enclosure: PS 1, C-C Plugged or better, Exterior grade.
   2. Plywood Exposed to View But Not Exposed to Weather: PS 1, A-D, or better.
   3. Other Locations: PS 1, C-D Plugged or better.

2.08 ACCESSORIES

A. Fasteners and Anchors:
   1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
   2. Drywall Screws: Bugle head, hardened steel, power driven type, length to achieve full penetration of sheathing substrate.
   3. Anchors: Toggle bolt type for anchorage to hollow masonry.

B. Die-Stamped Connectors: Hot dipped galvanized steel, sized to suit framing conditions.
   1. For contact with preservative treated wood in exposed locations, provide minimum G185 (Z550) galvanizing per ASTM A 653/A 653M.

C. Joist Hangers: Hot dipped galvanized steel, sized to suit framing conditions.
   1. For contact with preservative treated wood in exposed locations, provide minimum G185 (Z550) galvanizing per ASTM A 653/A 653M.

D. Sill Gasket on Top of Foundation Wall: 1/4 inch (6 mm) thick, plate width, closed cell plastic foam from continuous rolls.

E. Sill Flashing: As specified in Section 076200.

F. Water-Resistive Barrier: As specified in Section 072500.

G. Building Wrap: DuPont Tyvek Commercial Wrap; A flash spun-bonded olefin, non-woven, non-perforated secondary weather resistant barrier.
   1. DuPont Tyvek Tape, DuPont Weatherization Systems.
   2. For steel frame construction: DuPont Tyvek Wrap Cap Screws, DuPont Weatherization Systems. 1 5/8” rust resistant screws with 2: diameter plastic cap

3. For wood frame construction: DuPont Tyvek Wrap Caps, DuPont Weatherization Systems. Nails with large heads or plastic washers.
4. Caulks or Sealants: polyurethane or elastomeric sealants
    a. Available Products:
        1) OSI Quad Pro-Series, solvent release butyl rubber sealant
        2) DAP Dynaflex 230
        3) Other products as approved and recommended by air barrier/weather resistant barrier manufacturer.

H. Termite Shield: Galvanized Sheet Steel.

2.09 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
    1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
    2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

B. Fire Retardant Treatment:
    1. Manufacturers:
        a. Arch Wood Protection, Inc: www.wolmanizedwood.com.
        b. Hoover Treated Wood Products, Inc: www.frtw.com.
        c. Substitutions: See Section 016000 - Product Requirements.
    2. Exterior Type: AWPA Use Category UCFB, Commodity Specification H (Treatment C20 for lumber and C27 for plywood), chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E 84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D 2898.
        a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
        b. Treat all exterior rough carpentry items.
        c. Do not use treated wood in direct contact with the ground.
    3. Interior Type A: AWPA Use Category UCFA, Commodity Specification H (Treatment C20 for lumber and C27 for plywood), low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E 84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
        a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
        b. Treat rough carpentry items as indicated.
        c. Do not use treated wood in applications exposed to weather or where the wood may become wet.

C. Preservative Treatment:
    1. Manufacturers:
        a. Arch Wood Protection, Inc: www.wolmanizedwood.com.
        b. Chemical Specialties, Inc: www.treatedwood.com.
        c. Osmose, Inc: www.osmose.com.
        d. Substitutions: See Section 016000 - Product Requirements.

2. Preservative Pressure Treatment of Lumber Above Grade: AWPA Use Category UC3B, Commodity Specification A (Treatment C2) using waterborne preservative to 0.25 lb/cu ft (4.0 kg/cu m) retention.
    a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
    b. Treat lumber exposed to weather.
    c. Treat lumber in contact with roofing, flashing, or waterproofing.
    d. Treat lumber in contact with masonry or concrete.
    e. Treat lumber less than 18 inches (450 mm) above grade.
    f. Treat lumber in other locations as indicated.
3. Preservative Pressure Treatment of Plywood Above Grade: AWPA Use Category UC2 and UC3B, Commodity Specification F (Treatment C9) using waterborne preservative to 0.25 lb/cu ft (4.0 kg/cu m) retention.
    a. Kiln dry plywood after treatment to maximum moisture content of 19 percent.
    b. Treat plywood in contact with roofing, flashing, or waterproofing.
    c. Treat plywood in contact with masonry or concrete.
    d. Treat plywood less than 18 inches (450 mm) above grade.
    e. Treat plywood in other locations as indicated.
4. Preservative Pressure Treatment of Lumber in Contact with Soil: AWPA Use Category UC4A, Commodity Specification A (Treatment C2) using waterborne preservative to 0.4 lb/cu ft (6.4 kg/cu m) retention.
    a. Preservative for Field Application to Cut Surfaces: As recommended by manufacturer of factory treatment chemicals for brush-application in the field.
    b. Restrictions: Do not use lumber or plywood treated with chromated copper arsenate (CCA) in exposed exterior applications subject to leaching.

2.10 FABRICATION

A. Fabricate in sizes and shapes indicated and using details indicated.

B. Edges and trim to be scribed to fit may be left loose.

C. Work preservative treated wood in accordance with treatment manufacturer's recommendations; treat cut surfaces as recommended.

PART 3 - EXECUTION

3.01 PREPARATION

A. Where wood framing bears on cementitious foundations, install full width sill flashing continuous over top of foundation, lap ends of flashing minimum of 4 inches (100 mm) and seal.

B. Install sill gasket under sill plate of framed walls bearing on foundations; puncture gasket cleanly to fit tightly around protruding anchor bolts.

C. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

A. Select material sizes to minimize waste.

B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 FRAMING INSTALLATION

A. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.

B. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.

C. Install structural members full length without splices unless otherwise specifically detailed.

D. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AFPA Wood Frame Construction Manual.

E. Install horizontal spanning members with crown edge up and not less than 1-1/2 inches (38 mm) of bearing at each end.

F. Construct double joist headers at floor and ceiling openings and under wall stud partitions that are parallel to floor joists; use metal joist hangers unless otherwise detailed.

G. Provide bridging at joists in excess of 8 feet (2.3 m) span at mid-span. Fit solid blocking at ends of members.

H. Frame wall openings with two or more studs at each jamb; support headers on cripple studs.

3.04 BLOCKING, NAILERS, AND SUPPORTS

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

B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to code authorities may be used in lieu of solid wood blocking.

C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.

D. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.

E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.

F. Specifically, provide the following non-structural framing and blocking:
   1. Cabinets and shelf supports.
   2. Wall brackets.
   3. Handrails.
   4. Grab bars.
   5. Towel and bath accessories.
   6. Wall-mounted door stops.
   7. Wall paneling and trim.
   8. Joints of rigid wall coverings that occur between studs.

3.05 ROOF-RELATED CARPENTRY

A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.

B. Provide wood curb at all roof openings except where prefabricated curbs are specified and where specifically indicated otherwise. Form corners by alternating lapping side members.

3.06 INSTALLATION OF CONSTRUCTION PANELS

A. Subflooring/Underlayment Combination: Glue and nail to framing; staples are not permitted.

B. Subflooring: Glue and nail to framing; staples are not permitted.

C. Underlayment: Secure to subflooring with nails and glue.
   1. At locations where resilient flooring will be installed, fill and sand splits, gaps, and rough areas.
   2. Place building paper between floor underlayment and subflooring.

D. Roof Sheathing: Secure panels with long dimension perpendicular to framing members, with ends staggered and over firm bearing.
   1. Use sheathing clips between roof framing members.
   2. Nail panels to framing; staples are not permitted.

E. Wall Sheathing: Secure with long dimension parallel to wall studs, with ends over firm bearing and staggered, using nails or screws.
   1. Use plywood or other acceptable structural panels at building corners, for not less than 48 inches (1220 mm), measured horizontally.
   2. Place water-resistive barrier horizontally over wall sheathing, weather lapping edges and ends.

F. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches (610 mm) on center on all edges and into studs in field of board.
   1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
   2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
   3. Install adjacent boards without gaps.
   4. Size: 48 by 96 inches (2440 by 4880 mm), installed horizontally at ceiling height.

3.07 INSTALLATION OF BUILDING WRAP

A. Install Building Wrap horizontally in strict accord with Manufacturer's instructions for a Taped-edge system.

B. Install Building Wrap over exterior side of exterior wall sheathing to receive exterior finish in weatherboard fashion, free of tears or gaps. Lap edges at least 2-inches and ends at least 6-inches. Fasten with corrosion resistant staples.

C. Tape all horizontal and vertical seams and door and window openings.

D. Seal all tears and cuts in air barrier with tape approved by manufacturer.

3.08 SITE APPLIED WOOD TREATMENT

A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.

B. Allow preservative to dry prior to erecting members.

3.09 TOLERANCES

A. Framing Members: 1/4 inch (6 mm) from true position, maximum.

B. Surface Flatness of Floor: 1/8 inch in 10 feet (1 mm/m) maximum, and 1/4 inch in 30 feet (7 mm in 10 m) maximum.

C. Variation from Plane (Other than Floors): 1/4 inch in 10 feet (2 mm/m) maximum, and 1/2 inch in 30 feet (14 mm in 10 m) maximum.

3.10 CLEANING

A. Waste Disposal: Comply with the requirements of Section 017000.
   1. Comply with applicable regulations.

2. Do not burn scrap on project site.
3. Do not burn scraps that have been pressure treated.
4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

SECTION 061753

SHOP-FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Wood roof trusses.
   2. Wood girder trusses.
   3. Wood truss bracing.
   4. Metal truss accessories.

1.03 Related Requirements:

1. Section 061600 "Sheathing" for roof sheathing.

1.04 DEFINITIONS

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

1.05 ACTION SUBMITTALS

A. Product Data: For metal-plate connectors, metal truss accessories, and fasteners.

B. Shop Drawings: Show fabrication and installation details for trusses.
   1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
   2. Indicate sizes, stress grades, and species of lumber.
   3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
   4. Indicate locations, sizes, and materials for permanent bracing required to prevent buckling of individual truss members due to design loads.
   5. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
   6. Show splice details and bearing details.

C. Delegated-Design Submittal: For metal-plate-connected wood trusses indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For metal connector-plate manufacturer and fabricator.

B. Material Certificates: For dimension lumber specified to comply with minimum specific gravity. Indicate species and grade selected for each use and specific gravity.

C. Product Certificates: For metal-plate-connected wood trusses, signed by officer of truss fabricating firm.

D. Evaluation Reports: For the following, from ICC-ES:
   1. Metal-plate connectors.
   2. Metal truss accessories.

1.07 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.
   1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
   2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction.

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

1.08 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations in TPI BCSI**,** "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."
   1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
   2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
   3. Provide for air circulation around stacks and under coverings.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-plate-connected wood trusses.

B. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.
   1. Design Loads: As indicated on drawings.
   2. Maximum Deflection Under Design Loads:
      a. Roof Trusses: Vertical deflection of 1/240 of span for total loads.
      b. Roof Trusses: Vertical deflection of 1/360 of span for live loads.

C. Comply with applicable requirements and recommendations of the following publications:
   1. TPI 1, "National Design Standard for Metal Plate Connected Wood Truss Construction."
   2. TPI DSB, "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."
   3. TPI BCSI, "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."

D. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."

2.02 DIMENSION LUMBER

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules writing agency certi-

fied by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Provide dressed lumber, S4S.
3. Provide dry lumber with 19 percent maximum moisture content at time of dressing.

B. Minimum Chord Size for Roof Trusses: 2 by 6 inches nominal for both top and bottom chords.

C. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Section 061000 "Rough Carpentry."

2.03 METAL CONNECTOR PLATES

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. Alpine Engineered Products, Inc.; an ITW company.
2. MiTek Industries, Inc.; a subsidiary of Berkshire Hathaway Inc.
3. Truswal Systems Corporation; an ITW company.

B. Source Limitations: Obtain metal connector plates from single manufacturer.

C. General: Fabricate connector plates to comply with TPI 1.

D. Hot-Dip Galvanized-Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 coating designation; and not less than 0.036 inch thick.

2.04 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.

B. Nails, Brads, and Staples: ASTM F 1667.

2.05 METAL FRAMING ANCHORS AND ACCESSORIES

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]:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Simpson Strong-Tie Co., Inc.
2. USP Structural Connectors.

C. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of basis-of-design products. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

D. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 coating designation.
1. Use for interior locations unless otherwise indicated.

E. Truss Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening roof trusses to wall studs below, 2-1/2 inches wide by 0.062 inch thick. Tie fits over top of truss and fastens to both sides of truss, inside face of top plates, and both sides of stud below.

F. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, 1-1/4 inches wide by 0.050 inch thick. Clip is fastened to truss through slotted holes to allow for truss deflection.

G. Roof Truss Bracing/Spacers: U-shaped channels, 1-1/2 inches wide by 1 inch deep by 0.040 inch thick, made to fit between two adjacent trusses and accurately space them apart, and with tabs having metal teeth for fastening to trusses.

2.06 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20, with dry film containing a minimum of 94 percent zinc dust by weight.

2.07 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.

B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.

C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.
   1. Fabricate wood trusses within manufacturing tolerances in TPI 1.

D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

2.08 SOURCE QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform special inspections.
   1. Provide special inspector with access to fabricator's documentation of detailed fabrication and quality-control procedures that provide a basis for inspection control of the workmanship and the fabricator's ability to conform to approved construction documents and referenced standards.

B. Correct deficiencies in Work that special inspections indicate does not comply with the Contract Documents.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.

F. Space trusses as indicated; adjust and align trusses in location before permanently fastening.

G. Anchor trusses securely at bearing points; use metal truss tie-downs. Install fasteners through each fastener hole in metal framing anchors according to manufacturer's fastening schedules and written instructions.

H. Securely connect each truss ply required for forming built-up girder trusses.
   1. Anchor trusses to girder trusses as indicated.

I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
   1. Install bracing to comply with Section 061000 "Rough Carpentry."

J. Install wood trusses within installation tolerances in TPI 1.

K. Do not alter trusses in field. Do not cut, drill, notch, or remove truss members.

L. Replace wood trusses that are damaged or do not meet requirements.
   1. Damaged trusses may be repaired according to truss repair details signed and sealed by the qualified professional engineer responsible for truss design, when approved by Architect.

3.02 REPAIRS AND PROTECTION

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

B. Protect wood trusses from weather. If, despite protection, wood trusses become wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

C. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

END OF SECTION

SECTION 062000

FINISH CARPENTRY

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Finish carpentry items.

B. Interior and exterior standing and running trim.

C. Plywood and/or Board paneling.

D. Hardware and attachment accessories.

1.02 RELATED SECTIONS

A. Section 061000 - Rough Carpentry: Support framing, grounds, and concealed blocking.

B. Section 074646 - Fiber Cement Siding.

C. Section 079200 – Joint Sealants.

D. Section 099000 - Paints and Coatings: Painting and finishing of finish carpentry items.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ANSI A135.4 - American National Standard for Basic Hardboard.

C. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. AWI/AWMAC (QSI) - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada.

E. AWPA C2 - Lumber, Timber, Bridge Ties and Mine Ties -- Preservative Treatment by Pressure Processes; American Wood-Preservers' Association.

F. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood-Preservers' Association.

G. BHMA A156.9 - American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association; (ANSI/BHMA A156.9).

H. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association.

I. PS 1 - Structural Plywood.

J. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce).

K. WDMA I.S.4 - Water-Repellent Preservative Non-Pressure Treatment for Millwork; Window and Door Manufacturers Association.

L. WI (MAN) - Manual of Millwork; Woodwork Institute.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate the work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.

B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

A. Product Data:
   1. Provide instructions for attachment hardware and finish hardware.
   2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
   3. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.

B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, accessories, to a minimum scale of 1-1/2 inch to 1 ft. (1:8).

1.06 QUALITY ASSURANCE

A. Erection Tolerances
   1. Maximum Variation from True Position: 1/16 inch.
   2. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.
   3. Accessibility for persons with disabilities:
      a. Refer to Division 1 and drawing titled “General Accessibility Requirements” along with all contract documents to determine dimensional requirements for assured accessibility.
      b. Do not knowingly install finish carpentry that does not conform to the above requirements. Report to Owner and Contractor immediately upon discovery of any conditions that would prevent compliance.

B. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum three years of documented experience

1.07 REGULATORY REQUIREMENTS

A. Conform to applicable code for fire retardant requirements.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect materials against weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Provide for air circulation within and around stacks and under temporary coverings.

B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

C. Protect work from moisture damage.

1.09 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
   1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

C. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit work to be performed and at least one coat of specified finish can be applied without exposure to rain, snow, or dampness.

D. Fit woodwork to actual construction. Field measure prior to fabrication.

E. Coordination Data
   1. Furnish manufacturer's instructions for fabrication, handling, storage, installation, and finishing of treated wood materials to fabricators and installers.

F. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

PART 2 - PRODUCTS

2.01 MATERIALS - GENERAL

A. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
   1. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
   2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.

B. MDF: ANSI A208.2, Grade 130, made with binder containing no urea-formaldehyde resin.

C. Softwood Plywood: DOC PS1.

D. Softwood lumber for framing and blocking: Southern Pine or Douglas Fir Larch Superior Species, quarter sawn, maximum moisture content 6%; grade 1 or better.

E. Unless otherwise indicated provide products of quality specified by AWI Architectural Woodwork Quality Standards Illustrated for Custom grade.

F. Provide materials having fire and smoke properties as required by applicable code.

G. End Sealer: Manufacturer's standard, transparent, colorless wood sealer that is effective in retarding the transmission of moisture at cross-grain cuts and is compatible with indicated finish.

H. Penetrating Sealer: Manufacturer's standard, transparent, penetrating wood sealer that is compatible with indicated finish.

2.02 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

B. Provide sustainably harvested wood, certified or labeled as specified in Section 016000.

2.03 LUMBER MATERIALS

A. Exterior Lumber Trim for Semitransparent-Stained Finish, Clear Finish, Opaque painted finish, and Unfinished Applications:
   1. Species and Grade: Southern pine, pressure-preservative treated; B&B, SPIB or Douglas Fir-Larch.
   2. Maximum Moisture Content: 15 percent with a t least 85 percent of shipment at 12 percent of less.
   3. Finger Jointing: Not allowed.
   4. Face Surface: Surfaced (smooth).

B. Exterior Moldings for Opaque, Painted Finish: Azek trim.
   1. Finger Jointing: Allowed if made with wet-use adhesive complying with ASTM D 5572.

2.04 SHEET MATERIALS

A. Construction Panel: Texture 1-11 plywood; APA 303-O/L face grade.
   1. Veneer Species: Douglas Fir.
   2. Veneer Grade: Face C min.
   3. Construction: Veneer core.
   4. Thickness: 5/8 inch, unless noted otherwise.
   5. Panel Size: 48 x 96 inches.
   6. Long Edges: Shiplapped.
   7. Face pattern: 3/8 -inch wide x 5/16-inch deep grooves at 4 and 8 inches on center.
   8. Finish: Heat and pressure-applied resin treated cellulose-fiber surface for stain.

B. Softwood Plywood Not Exposed to View: Any face species, veneer core; PS 1 Grade A-B; glue type as recommended for application.

2.05 ADHESIVE

A. Adhesive: Type recommended by laminate manufacturer to suit application.

B. Exterior Wood Glue: Waterproof resorcinol glue recommended by manufacturer for exterior carpentry use.

C. Paneling Adhesive: Comply with paneling manufacturer's written recommendations for adhesives.

D. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.

2.06 FASTENERS

A. Fasteners: Of size and type to suit application.

B. Concealed Joint Fasteners: Threaded steel.

C. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.
   1. Where galvanized finish is indicated, provide fasteners and anchorages with hot-dip galvanized coating complying with ASTM A 153/A 153M.
      a. All fasteners in pressure preservative and/or fire-retardant treated wood shall be galvanized.

2.07 ACCESSORIES

A. Lumber for Shimming, Blocking.

B. Plastic Edge Trim: Extruded convex shaped; smooth finish; self-locking serrated tongue; of width to match component thickness; color as selected.

C. Wood Filler: Solvent base, tinted to match surface finish color.

D. Flashing: Comply with requirements of Section 076200 for flashing materials installed in exterior carpentry.

2.08 HARDWARE

A. Hardware: Comply with BHMA A156.9.

2.09 WOOD TREATMENT

A. Preservative-Treated Materials
   1. For exposed Lumber: AWPA C2 or AWPA C31 - treated with inorganic boron. Kiln dry after treatment to a maximum moisture content of 19 percent.

2. Plywood: AWPA C9. Kiln dry after treatment to a maximum moisture content of 18 percent.
3. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
4. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
5. Do not use material that is warped or does not comply with requirements for untreated material.
6. Mark lumber with treatment quality mark of an inspection agency approved by ALSC's Board of Review.
    a. For exposed lumber indicated to receive no finish or a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
7. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
8. Application: all exterior applications above and/or in contact with soil and other locations indicated.

B. Fire-Retardant-Treated Materials
1. Lumber: Comply with performance requirements in AWPA C20, Exterior type or Interior Type A. Kiln dry after treatment to a maximum moisture content of 19 percent.
2. Plywood: Comply with performance requirements in AWPA C27, Exterior type or Interior Type A. Kiln dry after treatment to a maximum moisture content of 15 percent.
3. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants and provide materials that do not have marks from spacer sticks on the exposed face.
4. Do not use material that does not comply with requirements for untreated material or is warped or discolored.
5. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
    a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
    b. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
    c. Application: Where indicated, and/or where required by applicable codes and/or where a part of an assembly required to be non-combustible

C. Wood Preservative by Pressure Treatment (PT Type): AWPA Treatment C2 using water borne preservative with 0.25 percent retainage.

D. Redry wood after pressure treatment.

2.10 FABRICATION

A. Shop assemble work to maximum size practical for delivery to site, permitting passage through building openings.

B. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting only when shown on drawings.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Verify adequacy of backing and support framing.

E. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.02 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours.

C. Prime lumber to be painted, including both faces and edges. Cut to required lengths and prime ends. Comply with requirements in Division 9 Section “Paints and Coatings.”

3.03 INSTALLATION

A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
   1. Do not use manufactured units with defective surfaces, sizes, or patterns.

B. Install finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
   1. Scribe and cut finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
   2. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.
   3. Coordinate finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

C. Set and secure materials and components in place, plumb and level.

D. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch (1 mm). Do not use additional overlay trim to conceal larger gaps.

3.04 STANDING AND RUNNING TRIM INSTALLATION

A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches long, except where necessary. Stagger joints in adjacent and related standing and running trim. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.
   1. Install trim after gypsum board joint finishing operations are completed.
   2. Drill pilot holes in hardwood before fastening to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

B. Install exterior flat grain lumber with bark side exposed to weather.

C. Fit exterior joints to exclude water. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Plane backs of casings to provide uniform thickness across joints, where necessary for alignment.

3.05 PANELING INSTALLATION

A. Plywood Paneling: Select and arrange panels on each wall to minimize noticeable variations in grain character and color between adjacent panels. Leave 1/4-inch gap to be covered with trim at top, bottom, and openings. Install with uniform tight joints between panels.

1. Attach panels to supports with manufacturer's recommended panel adhesive and fasteners. Space fasteners as recommended by panel manufacturer.
2. Conceal fasteners to greatest practical extent.
3. Arrange panels with grooves and joints over supports. Fasten to supports with nails of type and at spacing recommended by panel manufacturer. Use fasteners with prefinished heads matching groove color.

B. Board Paneling: Install according to manufacturer's written instructions. Arrange in random-width pattern suggested by manufacturer unless boards or planks are of uniform width.
1. Install in full lengths without end joints.
2. Stagger end joints in random pattern to uniformly distribute joints on each wall.
3. Install with uniform end joints with only end-matched (tongue-and-groove) joints within each field of paneling.
4. Install with uniform end joints. Locate end joints only over furring or blocking.
5. Select and arrange boards on each wall to minimize noticeable variations in grain character and color between adjacent boards. Install with uniform tight joints between boards.
6. The following fastening systems will be acceptable:
   a. Fasten paneling by face nailing, setting nails, and filling over nail heads.
   b. Fasten paneling with trim screws, set below face and filled.
   c. Fasten paneling by blind nailing through tongues.
   d. Fasten paneling with paneling system manufacturer's concealed clips.
   e. Fasten paneling to gypsum wallboard with panel adhesive.

C. Apply preservative treatment in accordance with manufacturer's instructions.

D. Brush apply one coat of preservative treatment on wood in contact with cementitious materials. Treat site-sawn cuts.

E. Allow preservative to dry prior to erecting members.

3.06 TOLERANCES

A. Maximum Variation from True Position: 1/16 inch (1.5 mm).

B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch (0.7 mm).

3.07 ADJUSTING

A. Replace finish carpentry that is damaged or does not comply with requirements. Finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.08 CLEANING

A. Clean finish carpentry on exposed and semi-exposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.09 PROTECTION

A. Protect installed products from damage from weather and other causes during remainder of the construction period.

B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

SECTION 068200

GLASS FIBER & RESIN COMPOSITE PLASTICS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Furnishing and installation of all non-life support system fiberglass reinforced plastic:
   1. Support members
   2. Square tube shapes and connection pieces
   3. Sheet panels as detailed

1.02 RELATED SECTIONS

A. Section 076100 Sheet Metal Roofing

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. FM P7825 - Approval Guide; Factory Mutual Research Corporation.

C. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.

D. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.

1.04 DESIGN REQUIREMENTS

A. Design Live and Dead Loads: As required by applicable local codes or noted in drawings, with deflection limited to 1/360 of span.

B. Design items with sufficient strength for handling stresses.

1.05 SUBMITTALS

A. Product Data: Submit manufacturer's specifications, installation instructions, and general recommendations for each major product required.

B. Shop Drawings: Submit complete shop drawings for fabrication and erection, including plans, elevations, and large scale details of typical sections and connections.
   1. Provide layout, dimensions, and identification of each unit. (Contractor is responsible for correct fitting of all members.)
   2. Provide location and details of anchorage devices to be embedded in or fastened to other construction. Furnish templates if required for accurate placement.

C. Samples: Submit two, illustrating color, texture, and finish.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Five years of experience in the fabrication of similar FRP components.
   1. Accessories: Provide accessory items only as produced or recommended by manufacturer of primary products.

1.07 DELIVERY, STORAGE, AND HANDLING

A. All materials and equipment necessary for the fabrication and installation of the FRP gratings shall be stored before, during, and after shipment in a manner to prevent cracking, twisting, bending, breaking, chipping or damage of any kind to the materials or equipment, including damage due to over exposure to the sun. Any material which, in the opinion of the owner, has become damaged as to be unfit for use, shall be promptly removed from the site of work, and the contractor shall receive no compensation for damaged material or its removal.

B. Protect components from damage by retaining shipping protection in place until installation.

1.08 FIELD CONDITIONS

A. Do not install site fabricated components when site conditions may be detrimental to successful installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Glass Fiber and Resin Fabrications:
   1. Creative Pultrusions, Inc.; Roswell, NM (505) 347-2226
   2. Strongwell, Bristol, VA. 276-645-8000
   3. Substitutions: See Section 016000 - Product Requirements.

2.02 GENERAL

A. Materials used in the manufacture of the FRP products shall be new stock and shall be free from all defects and imperfections that might affect the performance of the finished product.

B. FRP products exposed to weather shall not only contain an ultra-violet inhibitor but also shall additionally receive one mil thick U.V. coating to shield from ultra-violet light.

C. After fabrication, all cut ends, holes and abrasions of FRP shapes shall be sealed with a compatible resin coating to prevent intrusion of moisture.

D. All exposed surfaces shall be smooth and true to form.

E. Color: All components to be neutral gray unless otherwise noted.

F. Substitutions: Products by other manufacturers, provided that they comply with the design and quality established by the contract documents, will be considered if submitted prior to bidding.

2.03 MISCELLANEOUS FRP STRUCTURAL SHAPES

A. Structural FRP members composition shall consist of a glass fiber reinforced vinyl ester resin matrix, approximately 50% resin to glass ratio. A synthetic surface veil shall be the outermost layer covering the exterior surfaces. Continuous glass strand rovings shall be used internally for longitudinal strength. Continuous strand glass mats shall be used internally for transverse strength.

B. The following minimum material properties shall apply:
   1. Ultimate tensile stress in longitudinal direction; ASTM D638, 30,000 psi.
   2. Ultimate compressive stress in longitudinal direction; ASTM D695, 30,000 psi.
   3. Ultimate flexural stress in longitudinal direction; ASTM D790, 30,000 psi.
   4. Ultimate short beam shear in longitudinal direction; ASTM D2344, 4,500 psi.
   5. Ultimate tensile stress in transverse direction; ASTM D638, 7,000 psi.
   6. Ultimate compressive stress in transverse direction; ASTM D695, 15,000 psi.
   7. Ultimate flexural stress in transverse direction; ASTM D790, 10,000 psi.
   8. Barcol Hardness; ASTM D2583, 45.

C. Manufacturers:
   1. Creative Pultrusions, Inc.; Roswell, NM (505) 347-2226
   2. Strongwell, Bristol, VA. 276-645-8000
   3. Substitutions: Products by other manufacturers, provided they comply with the design and quality established by the contract documents, will be considered if submitted prior to bidding.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Inspect substrates and conditions under which the work of this section will be performed, and verify that installation properly may commence. Do not proceed with the work until unsatisfactory conditions have been resolved fully. Verify that surfaces are ready to receive work and dimensions are as indicated on shop drawings.

3.02 INSTALLATION

A. General: Comply with manufacturer's instructions, except where more stringent requirements are shown or specified, and except where project conditions require extra precautions or provisions to ensure satisfactory performance of the work.

B. Install fabrications in accordance with shop drawings and fabricator's instructions.

3.03 TOLERANCES

A. Maximum variation from true position: 1/4 inch (6 mm).

B. Maximum offset from true alignment: 1/8 inch (3 mm).

3.04 CLEANING

A. Clean components of foreign material without damaging finished surface.

B. Hand rub smooth surfaces with polishing cream.

C. Clean fabrications in accordance with fabricator's instructions.

3.05 PROTECTION

A. Place protective structural covering over installed units.

END OF SECTION

SECTION 072100

THERMAL INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Perimeter insulation under slabs on grade.

B. Cavity wall insulation.

C. Board insulation and integral vapor retarder at cavity wall construction, perimeter foundation wall, underside of floor slabs, and exterior wall behind wall finish.

D. Batt insulation and vapor retarder in exterior wall and as indicated on drawings.

E. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 RELATED SECTIONS

A. Section 054000 - Cold Formed Metal Framing: Supporting construction for batt insulation.

B. Section 061000 - Rough Carpentry: Supporting construction for batt insulation.

C. Section 072500 - Weather Barriers: Vapor retarders not integral to the insulation.

D. Section 079200 - Joint Sealants

E. Section 092116 - Gypsum Board Assemblies.

1.03 DEFINITIONS

A. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

1.04 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

C. ASTM C 612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

D. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

E. ASTM D 2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.

F. ASTM D 4397 - Specifications for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.

G. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

H. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials.

I. ASTM E 119 - Test Methods for Fire Tests of Building Construction and Materials.

J. ASTM E 136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace At 750 Degrees C.

K. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association.

L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.

1.05 SUBMITTALS

A. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

B. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.

B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
   1. Surface Burning Characteristics: ASTM E 84.
   2. Fire Resistance Rating: ASTM E 119.
   3. Combustion Characteristics: ASTM E 136.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect plastic insulation as follows:
   1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
   2. Do not deliver plastic insulating materials to Project site before installation time.
   3. Protect against ignition at all times.
   4. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
   5. Damaged or deteriorated materials shall be removed from the site.

C. Sequence work to ensure fireproofing and firestop materials are in place before beginning work of this section.

1.08 COORDINATION

A. Coordinate the work with Section 072500 for installation of vapor retarder.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
   2. Substitutions: See Section 016000 - Product Requirements.

2.02 APPLICATIONS

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

B. Insulation in Wood Framed Walls: Batt insulation with separate vapor retarder.

C. Insulation in Wood Framed Ceiling Structure: Batt insulation with separate vapor retarder.

D. Insulation Above Lay-In Acoustical Ceilings: Batt insulation with no vapor retarder, unless noted otherwise on drawings.

2.03 FOAM PLASTIC BOARD INSULATION MATERIALS

A. Expanded Polystyrene Board Insulation: ASTM C 578; with the following characteristics:
   1. Board Size: 48 x 96 inch (1220 x 2440 mm).
   2. Board Thickness: as noted on drawings.
   3. Board Edges: Square.
   4. Water Absorption: 4 percent by volume, maximum, when tested In accordance with ASTM D 2842.
   5. Thermal Conductivity (k factor) at 25 degrees F (-3.9 degrees C): as noted on drawings.
   6. Manufacturers:
      a. AFM Corp: www.r-control.com
      b. Diversifoam Products: www.diversifoam.com
      c. Grace Construction Products: www.na.graceconstruction.com
      d. Substitutions: See Section 016000 - Product Requirements

B. Extruded Polystyrene Board Insulation: ASTM C 578, Type X; Extruded polystyrene board with either natural skin or cut cell surfaces; with the following characteristics:
   1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E 84.
   2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E 84.
   3. Board Size: 48 x 96 inch (1220 x 2440 mm).
   4. Board Thickness: 1-1/2 inches (37.5 mm).
   5. Board Edges: Square.
   6. Thermal Conductivity (k factor) at 25 degrees F (-3.9 degrees C): 0.18 (0.31).
   7. Compressive Resistance: 15 psi (104 kPa).
   8. Board Density: 1.3 lb/cu ft (21 kg/cu m).
   9. Water Absorption, maximum: 0.3 percent, volume.
   10. Manufacturers:
      a. Dow Chemical Co: www.dow.com.
      b. Owens Corning Corp: www.owenscorning.com.
      c. Pactiv Building Products: www.pactiv.com/green-guard/.
      d. Substitutions: See Section 016000 - Product Requirements.

2.04 SLAG WOOL FIBER/ROCK WOOL FIBER BOARD INSULATION

A. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Insulation: ASTM C 612, maximum flame-spread and smoke-developed indexes of 15 and 0, respectively; passing ASTM E 136 for combustion characteristics.
   1. Thickness: as noted on the drawings.
   2. Flame Spread Index: 25 or less, when tested in accordance with ASTM E 84.
   3. Smoke Developed Index: 50 or less, when tested in accordance with ASTM E 84.
   4. Board Size: 48 x 48 inch (1220 x 1220 mm).
   5. Board Thickness: 1 inches (25 mm).
   6. Board Edges: Square.
   7. Thermal Conductivity (k factor): 0.26 (0.45).
   8. Maximum Density: 8.0 lb/cu ft (128 kg/cu m).
   9. Combustibility: Except for facing, if any, non-combustible when tested in accordance with ASTM E 136.
   10. Manufacturers:
      a. CertainTeed Corporation: www.certainteed.com
      b. Johns Manville Corporation: www.jm.com
      c. Owens Corning Corp: www.owenscorning.com
      d. Substitutions: See Section 016000 - Product Requirements

B. Mineral Fiber Board Insulation: Rigid mineral fiber, ASTM C 612; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E 84.
   1. Where indicated, provide foil facing on one side; with flame spread index of 25 or less, when tested in accordance with ASTM E 84.
   2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E 84.
   3. Board Size: 48 x 48 inch (1220 x 1220 mm).
   4. Board Thickness: as noted on drawings.
   5. Thermal Resistance: as noted on drawings.
   6. Manufacturers:
      a. Thermafiber, Inc: www.thermafiber.com.
      b. Substitutions: See Section 016000 - Product Requirements

2.05 GLASS FIBER BLANKET INSULATION

A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option.

B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C 655; friction fit.

C. Manufacturers:
   1. CertainTeed Corporation
   2. Johns Manville
   3. Owens Corning

D. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

E. Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type III (blankets with reflective membrane facing), Class A (membrane-faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier), faced with foil-scrim, vapor-retarder membrane on 1 face.

F. Where glass-fiber blanket insulation is indicated by the following thicknesses, provide blankets in batt or roll form with thermal resistances indicated:
   1. 3-1/2 inches thick with an R value of 11.
   2. 3-5/8 inches thick with an R value of 11.
   3. 5-1/2 inches thick with an R value of 19.
   4. 6-1/2 inches thick with an R value of 21.
   5. 9-1/2 inches thick with an R value of 30.

G. Batt Insulation: ASTM C 665; preformed batt; friction fit, conforming to the following:
   1. Material: Glass or mineral fiber.
   2. Substitutions: See Section 016000 - Product Requirements.

H. Mineral Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C 665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E 84.
   1. Where indicated, provide foil facing on one side; with flame spread index of 25 or less, when tested in accordance with ASTM E 84.
   2. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E 84.

2.06 VAPOR RETARDERS

A. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).

B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

2.07 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

B. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide cross ventilation between insulated attic spaces and vented eaves.

2.08 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
   1. Manufacturers/Products:
      a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
      b. Eckel Industries of Canada; Stic-Klip Type N Fastners.
      c. Gemco; Spindle Type.
   2. Plate: Perforated galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   3. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

B. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:
   1. Manufacturers/Products:
      a. Gemco; 90-degree Insulation Fasteners
   2. Angle: Formed from 0.030-inch- thick, perforated, galvanized carbon-steel sheet with each leg 2 inches square.
   3. Spindle: Copper-coated, low carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation indicated.

C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
   1. Manufacturers/Products:
      a. AGM Industries, Inc.; RC150.
      b. AGM Industries, Inc.; SC150
      c. Gemco; Dome-Cap.
      d. Gemco; R-150
      e. Gemco; S-150.
   2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
      a. Crawlspaces.
      b. Ceiling plenums.
      c. Attic spaces.
      d. Where indicated.

D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch between face of insulation and substrate to which anchor is attached.
   1. Manufacturers/Products:
      a. Gemco; Clutch Clip.

E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
   1. Manufacturers/Products:
      a. AGM Industries, Inc.; TACTOO Adhesive

b. Eckel Industries of Canada; Stic-Klip Type S Adhesive
c. Gemco; Tuff Bond Hanger Adhesive

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation and adhesive.

B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrates of substances harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders or of interfering with insulation attachment.

3.03 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, snow or any other moisture.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement. Do not compress insulation.

D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

E. For preformed insulating units, 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.

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

3.04 BOARD INSTALLATION

A. Secure impale fasteners to substrate at a frequency as recommended by manufacturer.

B. Apply adhesive to back of boards:

C. Install boards to fit snugly between wall ties.

D. Install boards:
   1. Place boards to maximize adhesive contact.
   2. Install in running bond pattern.
   3. Butt edges and ends tightly to adjacent boards and to protrusions.
   4. Place impale fastener locking discs.

E. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.05 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Seal joints between foam-plastic insulation units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.

C. Set vapor-retarder-faced units with vapor retarder toward the prevailing warm side as directed by the manufacturer and is appropriate application for the surrounding climate within construction, unless otherwise indicated.
   1. Tape joints and ruptures in vapor retarder, and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

D. Install mineral-fiber insulation and sound attenuation in cavities formed by framing members according to the following requirements:
   1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
   2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
   3. Maintain 3-inch clearance of insulation around recessed lighting fixtures.
   4. Install eave ventilation troughs between roof framing members in insulated attic spaces at vented eaves.
   5. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
   6. For wood-framed construction, install mineral-fiber blankets according to ASTM C 1320 and as follows:
      a. With faced blankets having stapling flanges, secure insulation by inset, stapling flanges to sides of framing members.
      b. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.
   7. Insulation that does not fill the entire thickness of a cavity shall be secured with anchors as specified to prevent settlement of the insulation.

E. Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces where shown. Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

3.06 INSTALLATION OF INSULATION IN CEILINGS FOR SOUND ATTENUATION

A. Install 3-inch thick, unfaced slag-wool-fiber/rock-wool-fiber blanket insulation over suspended ceilings at partitions in a width that extends insulation 48 inches on either side of partition.

B. Do not allow weight of insulation onto acoustic panels.

3.07 INSTALLATION OF VAPOR RETARDERS

A. General: Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping not less than two wall studs. Fasten vapor retarders to wood framing at top, end, and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches o.c.

C. Before installing vapor retarder, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.

D. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.

E. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarder.

F. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarder.

G. Install insulation and vapor retarder in accordance with manufacturer's instructions.

H. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.

I. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

J. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

K. Install vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane.

L. Tape seal tears or cuts in vapor retarder.

M. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane. Tape seal in place.

3.08 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

SECTION 072500

WEATHER BARRIERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Exterior walls:
   1. Vapor retarder – Not integral with insulation
   2. Moisture barrier.
   3. Air barrier.

B. Vapor Retarders: Materials to make exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls water vapor-resistant and air-tight.

C. Air Barriers: Materials to stop passage of air through exterior walls, joints between exterior walls and roof, and joints around frames of openings in exterior walls.

1.02 RELATED SECTIONS

A. Section 033000 - Concrete General.

B. Section 054000 - Cold-Formed Metal Framing.

C. Section 061000 - Rough Carpentry.

D. Section 072100 - Thermal Insulation

E. Section 076200 - Sheet Metal Flashing and Trim

F. Section 092116 - Gypsum Board Assemblies: Exterior sheathing.

G. Division 31 - Earthwork.

1.03 DEFINITIONS

A. Weather Barrier: Assemblies that form either vapor retarders, moisture barriers and air barriers.

B. Vapor Retarder: Air-tight barrier made of material that is relatively water vapor impermeable, to the degree specified, with sealed seams and with sealed joints to adjacent surfaces.
   1. Water Vapor Permeance: For purposes of conversion, 57.2 ng/(Pa s sq m) = 1 perm.

C. Air Barrier: Air-tight barrier made of material that is relatively air impermeable but water vapor permeable, both to the degree specified, with sealed seams and with sealed joints to adjacent surfaces.

D. Moisture Barrier: Water-shedding barrier made of material that is moisture-resistant, to the degree specified, intended to be installed to shed water without sealed seams.

1.04 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. AATCC Test Method 127 - Water Resistance: Hydrostatic Pressure Test.

C. ASTM C 836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.

D. ASTM D 226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

E. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension.

F. ASTM D 1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.

G. ASTM D 4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.

H. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

I. ASTM E 1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

J. ASTM D 882 - Tensile Properties of This Plastic Sheeting.

K. ASTM D 1709 - Impact Resistance of Plastic Film by the Free-Falling Dart Method.

L. ASTM D 2582 - Puncture-Propogation Tear Resistance of Plastic Film and This Sheeting.

M. ASTM D 3776 - Mass per Unit Area (Weight) of Woven Fabric.

N. ASTM D 4833 - Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

O. ASTM D 4869 - Standard Specification for Asphalt-Saturated Organic Felt Shingle Underlayment Used in Roofing.

P. ASTM E 96 - Water Vapor Transmission of Materials.

Q. NFPA 701 - Fire Tests for Flame-Resistant Textiles and Films.

R. ASTM E 2178 - Standard Test Method for Air Permeance of Building Materials.

1.05 SUBMITTALS

A. Product Data: Manufacturer's specifications and installation instructions for all components of each product type specified, including typical details.

B. Samples: Submit samples for each vapor retarder and moisture barrier specified, 6 inches square.

C. Manufacturer's Installation Instructions: Indicate preparation and installation methods.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall have successful experience in the installation of vapor retarders and moisture barriers.

B. Mock-up: Mock-up panel shall contain proper installation of vapor retarders and moisture barriers according to manufacturer's requirements and accepted by Owner's representative.
   1. To be included in mock-up with items specified in other sections.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Store materials in a clean, dry area in accordance with manufacturer's instructions.

C. Protect materials during handling and installation to prevent damage.

PART 2 - PRODUCTS

2.01 CONCRETE SLABS (under slab):

A. Vapor Retarder (Product shall meet or exceed the following criteria):
   1. Basis of Design: VaporBlock 15; Raven Industries, Inc.
   2. Material: Single-ply, 15 mil, virgin polyolefin membrane.

3. Classification: ASTM E 1745; Class A.
4. Tensile Strength: ASTM E 154, Section 9; 77 lbs/in.
5. Puncture Resistance: ASTM D 1709, Method B; 4,000 g.
6. Permenace: ASTM E 154, Section 7; 0.025 U.S. perms.
7. Acceptable Manufacturers:
   a. VaporBlock 15; Raven Industries, Inc.; www.ravenind.com
   b. Griffolyn 15 Mil Green; Reef Industries, Inc.; www.reefindustries.com
8. Substitutions: See Section 016000 for product substitutions.
9. Accessories:
   a. Self-Adhesive Repair Tape: Vapor retarder manufacturer's standard repair tape.
   b. Pipe Boots: Provide pipe boots, factory-fabricated, as approved and recommended by vapor retarder manufacturer.

2.02 EXTERIOR WALL:

A. Vapor Retarder: (Product shall meet or exceed the following criteria.)
   1. Basis of Design: Dura-Skrim 2FR; Raven Industries, Inc.
   2. Material: Fire retardant 3-ply laminate, 2 layers of linear low-density polyethylene and 1 layer of high-strength non-woven cord grid.
   3. Classification: ASTM E 84; Class 1, Class A flame spread rating.
   4. Tensile Strength (1 inch): ASTM D 751; 40 lbf.
   5. Permeance: ASTM E 96; 0.058 g/100 square inch/day and Perm Rating of 0.13 U.S. Perms.
   6. Acceptable Manufacturers:
      a. Dura-Skrim 2FR; Raven Industries, Inc., www.ravenind.com
      b. Griffolyn Type 55 FR; Reef Industries, Inc., www.reefindustries.com
      c. Substitutions: See Section 016000 for product substitutions.
   7. Accessories:
      a. Mastic: Vapor retarder manufacturer's standard mastic.
      b. Self-Adhesive Repair Tape: Vapor retarder manufacturer's standard repair tape.
      c. Pipe Boots: Provide pipe boots, factory fabricated, as approved and recommended by vapor retarder manufacturer.

B. Moisture Barrier: (Product shall meet or exceed the following criteria)
   1. Basis of Design: Rufco Wrap; Raven Industries, Inc.
   2. Material: Flash spunbonded olefin, non-woven, non-perforated secondary weather moisture barrier.
   3. Water Vapor Transmission Rate: ASTM E 96A, 6.5 perms.
   4. Water Penetration Resistance: TAPPI T433-CM-84, exceeds 10 minute requirement.
   5. Wind Driven Rain: ASTM 1677, Type 1, passed.
   6. Air Leakage: ASTM E 283, 0.017 cubic feet/minute.
   7. Classification: ASTM E 84 A, Class 1, Class A flame rating.
   8. Acceptable Manufacturers:
      a. Rufco Wrap: Raven Industries, Inc.; www.ravenind.com
      b. Tyvek Commercial Wrap: DuPont; www.dupont.com
      c. Substitutions: See Section 016000 for product substitutions.
   9. Accessories:
      a. Tape: Provide moisture barrier manufacturer's weatherization system.
      b. Fasteners: For steel frame construction, use manufacturer's rust resistant screws with plastic cap.
      c. Joint Sealers: Provide polyurethane or elastomeric sealants as approved and recommended by moisture barrier manufacturer.

2.03 SLOPING ROOF:

A. Vapor Retarder: (Product shall meet or exceed the following criteria.)
   1. Basis of Design: Dura-Skrim 2FR; Raven Industries, Inc.

2. Material: Fire retardant 3-ply laminate, 2 layers of linear low-density polyethylene and 1 laye high-strength non-woven cord grid.
3. Classification: ASTM E 84, Class 1, Class A flame spread rating.
4. Tensile Strength (1 inch): ASTM d 751; 40 lbf.
5. Permeance: ASTM E 96; 0.058 g/100 square inches/day and Perm Rating, 0.13 U.S. Perms.
6. Acceptable Manufacturers:
   a. Dura-Skrim 2FR; Raven Industries, Inc.; www.ravenind.com
   b. Griffolyn Type-55 FR; Reef Industries, Inc.; www.reefindustries.com
   c. Substitutions: See Section 016000 for product substitutions.
7. Accessories:
   a. Mastic: Vapor Retarder manufacturer's standard mastic.
   b. Self-Adhesive Repair Tape: Vapor retarder manufacturer's standard repair tape.
   c. Pipe Boots: Provide pipe boots, factory-fabricated, as approved and recommended by vapor retarder manufacturer.

B. Moisture Barriers: (Product shall meet or exceed the following criteria.)
1. Underlayment: (Roofing Felts)
   a. Felt: ASTM D 226, Type II, asphalt saturated organic felts, nonperforated.
2. Underlayment: (Ice/Water Shield)
   a. Basis of Design: Roof Shield by Proctor Group
   b. Self-Adhering Sheet Underlayment, Granular Surfaced: ASTM D 1970, minimum of 55 mil thick sheet; glass fiber mat reinforced, SBS modified asphalt; mineral granule surfaced with release paper backing, cold applied. Provide primer for adjoining concrete or masonry surfaces t receive underlayment.
   c. Acceptable Manufacturers
      1) WinterGuard Sand; CertainTeed Corporation; www.certainteed.com
      2) CCW WIP Self-Adhering Roofing Underlayment: Carlisle Coatings & Waterproofing, Inc.; www.carlisle-ccw.com
      3) Substitutions: See Section 016000 for product substitutions.
      d. Compliance with ASTM D 1970.
3. Accessories:
   a. Fasteners: Use manufacturer's rust resistant nails. Coordinate underlayment fasteners with limitations and requirements of remaining roof system.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions to receive reinforced vapor retarders and moisture barriers. Notify Architect if areas are not acceptable.

B. Do not begin installation until unacceptable conditions have been corrected.

3.02 PREPARATION

A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.

3.03 INSTALLATION

A. General: Installation per manufacturer's recommendations.

B. Concrete Slab: (Under concrete slab)
1. Vapor Retarder:
   a. Install moisture barrier over exterior side of exterior wall sheathing according to manufacturer's instructions.
   b. Install reinforced vapor retarders in accordance with ASTM E 1643 and manufacturer's instructions.

c. Install vapor retarders continuously at locations under new concrete slabs unless indicated otherwise.
d. Ensure continuity in vapor retarder at seams and penetrations.
e. Install vapor retarders in largest practical widths.
f. Ensure subgrade beneath vapor retarder is smooth, level, and compacted with no sharp projections.
g. Join sections of vapor retarder and seal penetrations in vapor retarder with mastic tape.
h. Ensure vapor retarder surfaces to receive mastic tape are clean and dry.
i. Ensure there is no moisture entrapment by vapor retarder due to rainfall or ground water intrusion.
j. Immediately repair holes in vapor retarder with self-adhesive repair tape or as required by manufacturer.
k. Seal around pipes and other penetrations in vapor retarder with pipe boots in accordance with manufacturer's instructions.

C. Exterior Wall:
1. Vapor Retarder:
a. Install reinforced vapor retarders in accordance with manufacturer's instructions.
b. Install vapor retarders continuously at locations on walls as indicated on the drawings.
c. Ensure there are no discontinuities in vapor retarder at seams and penetrations.
d. Install vapor retarders in largest practical widths.
e. Ensure surface behind vapor retarder is smooth with no sharp projections.
f. Join sections of vapor retarder and seal penetrations in vapor retarder with mastic tape.
g. Ensure vapor retarder surfaces to receive mastic tape are clean and dry.
h. Immediately repair holes in vapor retarder with self-adhesive repair tape.
i. Seal around pipes and other penetrations in vapor retarder with pipe boots in accordance with manufacturer's instructions.
2. Moisture Barrier:
a. Install moisture barrier over exterior side of exterior wall sheathing according to manufacturer's instructions.
b. Install moisture barrier after sheathing is installed and before windows and doors are installed. Install lower level barrier prior to upper layers to ensure proper shingling of layers.
c. Overlap moisture barrier at corners of building by a minimum of 12 inches.
d. Overlap moisture barrier vertical seams by a minimum of 6 inches.
e. Ensure barrier is plum and level with foundation, and unroll extending moisture barrier over window and door openings.
f. Attach moisture barrier to substrate according to manufacturer's instructions.
g. Prepare and install manufacturer's standard flashing systems at window and door rough openings according to manufacturer's instructions.
h. Tape all horizontal and vertical seam of moisture barrier with manufacturer's tape.
i. Seal all tears and cuts in moisture barrier with manufacturer's recommended tape.

D. Sloping Roofs:
1. Vapor Retarder:
a. Install reinforced vapor retarders in accordance with manufacturer's instructions.
b. Install vapor retarders continuously at locations on roof deck as indicated on the drawings.
c. Ensure there are no discontinuities in vapor retarder at seams and penetrations.
d. Install vapor retarders in largest practical widths.
e. Ensure surface beneath vapor retarder is smooth with no sharp projections.
f. Join sections of vapor retarder and seal penetrations in vapor retarder with mastic tape.
g. Ensure vapor retarder surfaces to receive mastic tape are clean and dry.
h. Immediately repair holes in vapor retarder with self-adhesive repair tape.

i. Seal around pipes and other penetrations in vapor retarder with pipe boots in accordance with manufacturer's instructions.

2. Moisture Barrier: (underlayment)
   a. General: Comply with underlayment manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.
   b. Underlayment: (Roofing Felts)
   c. Single-Layer Felt Underlayment: Install on roof deck parallel with and starting at the eaves. Lap sides a minimum of 2 inches over underlying course. Lap ends a minimum of 4 inches. Stagger end laps between succeeding courses at least 72 inches. Fasten with roofing nails.
   d. Install felt underlayment on roof deck not covered by self-adhering sheet underlayment. Lap sides of felt over self-adhering sheet underlayment not less than 3 inches in direction to shed water. Lap ends of felt not less than 6 inches over self-adhering sheet underlayment.
   e. Install fasteners at no more than 36 inch o.c.
3. Underlayment: (Ice/Water Shield)
   a. Self-Adhering Sheet Underlayment: Install, wrinkle free, on roof deck. Comply with low-temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below lapped in direction to shed water. Lap sides not less than 3-1/2 inches. Lap ends not less than 6 inches staggered 24 inches between courses. Roll laps with roller. Cover underlayment within seven days.
   b. Prime concrete and masonry surfaces to receive self-adhering sheet underlayment.
   c. Eaves: Extend from edges of eaves 36 inches beyond interior face of exterior wall.
   d. Rakes: Extend from edges of rake 36 inches beyond interior face of exterior wall.
   e. Valleys: Extend from lowest to highest point 18 inches on each side.
   f. Hips: Extend 18 inches on each side.
   g. Ridges: Extend 36 inches on each side.
   h. Sidewalls: Extend beyond sidewall 18 inches, and return vertically against sidewall not less than 4 inches.
   i. Dormers, Chimneys, Skylights, and Other Roof-Penetrating Elements: Extend beyond penetrating element 18 inches, and return vertically against penetrating element not less than 4 inches.
   j. Roof Slope Transitions: Extend 18 inches on each roof slope.

E. Water-Resistive Barriers: Install continuous barrier over surfaces indicated, with sheets lapped to shed water but with seams not sealed.

F. Air Barriers: Install continuous air-tight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.
   1. Vapor Retarders: Install continuous air-tight barrier over surfaces indicated, with sealed seams and with sealed joints to adjacent surfaces.

G. Apply sealants and adhesives within recommended application temperature ranges. Consult manufacturer if temperature is out of this range.

3.04 FIELD QUALITY CONTROL

A. Do not cover installed weather barriers until required inspections have been completed.

B. Obtain approval of installation procedures by the weather barrier manufacturer based on a mock-up installed in place, prior to proceeding with remainder of installation.

C. Take digital photographs of each portion of the installation prior to covering up.

3.05 PROTECTION

A. Follow manufacturer's instructions for exposure and protection from sunlight.

B. Protect reinforced vapor retarders and moisture barriers from damage during construction.

C. Immediately repair damaged vapor retarders and moisture barriers in accordance with manufacturer's instructions.

D. Do not leave paper- or felt-based barriers exposed to weather for longer than one week.

END OF SECTION

SECTION 074623

WOOD SIDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Board, and Panel siding for walls with batten strips.

B. Rough sawn lap siding.

C. Trim, flashings, accessories, soffit vents, and fastenings.

1.02 RELATED SECTIONS

A. Section 054000 - Cold-Formed Metal Framing: Siding substrate support.

B. Section 061000 - Rough Carpentry: Siding substrate.

C. Section 072500 - Weather Barriers: Weather barrier under siding.

D. Section 076200 - Sheet Metal Flashing and Trim: Product requirements for metal flashings and trim associated with wood siding for placement by this section.

E. Section 079200 - Joint Sealants: Sealant at joints.

F. Section 081110 - Hollow Metal Doors And Frames: Assemblies abutting installations in this section.

G. Section 099000 - Paints and Coatings: Prime and finish painting.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. APA B840 - 303 Siding Manufacturing Specifications; APA - The Engineered Wood Association.

C. APA E445 - Performance Standards and Policies for Structural-Use Panels; APA - The Engineered Wood Association.

D. AWPA C2 - Lumber, Timber, Bridge Ties and Mine Ties -- Preservative Treatment by Pressure Processes; American Wood-Preservers' Association.

E. SPIB (GR) - Grading Rules; Southern Pine Inspection Bureau, Inc.

1.04 SUBMITTALS

A. Product Data: Provide data indicating materials, component profiles, fastening methods, jointing details, sizes, surface texture, finishes, and accessories.

B. Samples: Submit two samples 12 x 12 inch (300 x 300 mm) in size to applicator of finish paint for use in preparation of finish samples.

1.05 QUALITY ASSURANCE

A. Grade lumber in accordance with the following:
   1. Western Red Cedar: WCLB (GR).
   2. Plywood Specified by APA Grade or Type: Labeled by APA certified grading agency.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in ventilated areas with constant minimum temperature of 60 degrees F (16 degrees C) and maximum relative humidity of 55 percent.

PART 2 - PRODUCTS

2.01 SIDING

A. Trim Boards: Same species as siding: 1 x 6 inch nominal.
   1. Preservative Treatment: Pressure treatment in accordance with AWPA C2, using non-discoloring water borne preservative.

B. Siding Panels: APA rated siding, exterior exposure class, for use as wall siding, soffits and underside of exposed roof framing.
   1. Type: Georgia Pacific Plytanium Ply-Bead
   2. Specie: Southern Pine
   3. Groove spacing: 1.6” on center beaded pattern.
   4. Thickness: 1/2 inch.
   5. Fasteners for Walls: Hot-dip zinc coated screws.
   6. Groove direction on Vertical Planes: Vertical.
   7. Groove direction on Horizontal Planes: Perpendicular to structural members.

2.02 ACCESSORIES

A. Nails: Corrosion resistant type; non-staining, of size and strength to securely and rigidly retain the work.

B. Sheathing Paper: Sheet polyethylene, 10 mils (0.25 mm) thick.

C. Building Paper: As specified in Section 072500.

D. Flashing: As specified in Section 076200.

E. Soffit Vents: Superior V Vent SVVO38V200G"; Delta Star, Inc., 800-368-3017.

F. Accessory Components: Fascias of same material and finish as siding.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that substrates are ready to receive work.

B. Verify that water-resistive barrier has been installed over substrate completely and correctly.

C. Do not begin until unacceptable conditions have been corrected.

D. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Apply preservative treatment in accordance with manufacturer's instructions.
   1. Verify materials do not exceed the specified percent moisture content before applying wood preservative treatment.

B. Apply dip- or brush-type preservative to site-sawn ends of pressure preservative treated materials. Allow preservative to cure prior to erecting materials.

C. Back prime all boards to be exposed to weather.

D. Prime paint surfaces in contact with cementitious materials.

E. Do not install materials until site pre-finishing is complete and dry.

3.03 INSTALLATION

A. Wood Siding:
   1. Install siding in accordance with manufacturer's instructions.

2. Fasten siding in place, level and plumb.
3. Arrange for orderly nailing pattern. Blind nail except on over trim.
4. Install siding for natural shed of water.
5. Position cut ends over bearing surfaces. Sand cut edges smooth and clean.
6. Remove beveled edge where it would be otherwise visible.
7. When height of wall exceeds siding board length, miter and overlap adjoining edges of boards to shed water towards the outside of wall.

B. General:
1. Install layers of building paper or sheathing paper from base of surface to top, overlapping consecutive layers by minimum 8 inches.
2. Install corner strips where indicated.
3. Install metal flashings at internal and external corners, sills, and heads of wall openings.
4. Prime front and rear side of each board, prepare for site finishing.
5. Install joint sealer at locations with potential for moisture intrusion, do not seal wall cavities required for ventilation.
6. Install trim boards at corners and at the wall openings.
7. Sand work smooth and set exposed nails and screws.

END OF SECTION

SECTION 074646

FIBER CEMENT SIDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wood-fiber cement siding.

B. Fiber cement trim.

C. Sealing panel joints and penetrations.

1.02 RELATED SECTIONS

A. Section 072500 Weather Barriers; water resistive barrier.

B. Section 079200 - Joint Sealants.

C. Section 099000 - Painting and Coating: Field painting.

1.03 REFERENCE STANDARDS

A. ASTM C 1186 - Standard Specification for Flat Fiber Cement Sheets.

B. AHA A135.6 - Hardboard Siding.

C. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. ASTM E 136 - Test Method for Behavior of Materials in a Vertical Tube Furnace.

1.04 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Manufacturer's requirements for related materials to be installed by others.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods, including nail patterns.
   5. Applicable model code authority evaluation report (ICBO, SBCCI, BOCA, CCMC, etc.)

B. Test Report: Applicable model code authority evaluation report (e.g. ICC-ES).

C. Maintenance Instructions: Periodic inspection recommendations and maintenance procedures.

D. Samples: Submit two samples 12x12 inch in size illustrating surface texture.

E. Warranty: Submit copy of manufacturer’s warranty, made out in Owner’s name, showing that it has been registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing work of the type specified in this section with minimum 3 years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store products under waterproof cover and elevated above grade, on a flat surface.

PART 2 - PRODUCTS

2.01 SIDING

A. Manufacturers:
   1. James Hardie Building Products, Inc; www.jameshardie.com.
   2. All fiber cement siding products to be provided by a single manufacturer.
   3. Substitutions: See Section 016000 - Product Requirements.

B. General:
   1. Non-asbestos fiber-cement siding formed under high pressure with integral surface texture, complying with ASTM C1186 Type A, Grade II.
   2. Siding to be non-combustible when tested in accordance with ASTM test method E136.
   3. All Fiber cement siding to be primed on all edges.

C. Lap Siding: Individual horizontal boards with machined edges, for nail attachment.
   1. Style: Standard lap style.
   2. Texture: Smooth.
   3. Length: 12 ft (3.7 m), nominal.
   4. Width (Height): 5-1/4 inches (133 mm).
   5. Thickness: 5/16 inch (8 mm), nominal.
   6. Finish: Factory applied primer.
   7. Color: To be field painted unless noted otherwise.
   8. Warranty: 50 year limited.

D. Trim Boards:
   1. Texture: Simulated cedar grain.
   2. Length (Height): 144 inches nominal.
   3. Width: 4 inches.
   4. Thickness: 3/4 inch nominal.
   5. Finish: Factory applied primer.
   6. Color: To be field painted unless noted otherwise.

E. Panel Siding: Vertically oriented panels made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C 1186 Type A Grade II; with machined edges, for nail attachment.
   1. Texture: Simulated cedar grain vertically grooved.
   2. Length (Height): 108 inches (2700 mm), nominal.
   3. Width: 48 inches (1220 mm).
   4. Thickness: 5/16 inch (8 mm), nominal.
   5. Finish: Factory applied primer.
   6. Color: Factory-Primed, to be field painted unless noted otherwise.
   7. Warranty: 50 year limited.
   8. Batten Strips: Harditrim HLD; 4 x 3/4 inch, smooth, factory primed.

F. Soffit Panels: Panels made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C 1186 Type A Grade II; with machined edges, for nail attachment.
   1. Texture: Simulated cedar grain grooved.
   2. Length: 96 inches (2400 mm), nominal.
   3. Width: 48 inches (1220 mm).
   4. Thickness: 5/16 inch (8 mm), nominal.
   5. Finish: Factory applied primer.
   6. Color: To be field painted unless otherwise noted.

2.02 ACCESSORIES

A. Furring Strips: Galvanized metal channels.

B. Flashing: Refer to Section 076200.

C. Fasteners: Galvanized or corrosion resistant: strength and length as required to securely and rigidly retain the work. Exposed edges to be treated to match siding finish.

D. Joint Sealant: Refer to Section 079200.

E. Prime Paint: Hardie Prime Plus manufacturer by Valspar Corp.; compatible with acrylic and oil based topcoats.

F. Finish Paint: Latex house paint acceptable to siding manufacturer.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine substrate and clean and repair as required to eliminate conditions that would be detrimental to proper installation.

B. Verify that water-resistive barrier has been installed over substrate completely and correctly.

C. Do not begin until unacceptable conditions have been corrected.

D. If substrate preparation is the responsibility of another installer, notify Owner and Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Install sheet metal flashing:
   1. Above door and window trim and casings.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions and recommendations.
   1. Read warranty and comply with all terms necessary to maintain warranty coverage.
   2. Install in accordance with conditions stated in model code evaluation report applicable to location of project.
   3. Use trim details indicated on drawings.
   4. Touch up all field cut edges before installing.
   5. Pre-drill nail holes if necessary to prevent breakage.

B. Allow products to adjust to ambient conditions before starting installation.

C. Do not install to green wood or crooked structural framing. Do not install over rain soaked or buckled materials. Do not install if excessive moisture is present in the interior, including that from curing concrete and plaster

D. Over Wood and Wood-Composite Sheathing: Fasten siding through sheathing into studs.

E. Over Foam Sheathing: Read and comply with sheathing manufacturer's recommendations.
   1. For sheathing of 1 inch (25 mm) thickness or less, nail through sheathing into studs using correspondingly longer nails.
   2. For sheathing over 1 inch (25 mm) thickness, install furring strips over studs and fasten siding through furring and into studs.

F. Over Masonry Walls: Install furring strips of adequate thickness to accept full length of nails and spaced at minimum 16 inches (406 mm) on center. Leave space at top and bottom open; top may be behind soffit; at bottom install insect screen over opening by wrapping a strip of screen over bottom ends of vertical furring strips.

G. Over Steel Studs: Use hot-dipped galvanized self-tapping screws, with the points of at least 3 screws penetrating each stud the panel crosses and at panel ends.

H. Diagonal Siding: Follow manufacturer's instructions.

I. Allow space between both ends of siding panels that butt against trim for thermal movement; seal joint between panel and trim with exterior grade sealant.

J. Joints in Horizontal Siding: Avoid joints in lap siding except at corners; where joints are inevitable stagger joints between successive courses.

K. Joints in Vertical Siding: Install Z-flashing in horizontal joints between successive courses of vertical siding.

L. Do not install siding less than 6 inches (150 mm) from surface of ground nor closer than 1 inch (25 mm) to roofs, patios, porches, and other surfaces where water may collect.

M. Fasten siding in place, level and plumb.
   1. Arrange for orderly nailing pattern. Blind nail except on over trim.
   2. Install siding for natural shed of water.
   3. Position cut ends over bearing surfaces. Sand cut edges smooth and clean.

N. Install metal flashings at internal and external corners, sills and heads of wall openings.

O. After installation, seal all joints except lap joints of lap siding. Seal around all penetrations. Paint all exposed cut edges and sealant.

P. Touch-up prefinished paint surfaces that are disfigured. Unsightly touch-up will require removal and replacement of affected siding.

Q. Finish Painting: Refer to drawings for finish. Apply per Section 099000.

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 076100

SHEET METAL ROOFING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Preformed sheet metal roof panels.

B. Sheet metal flashing and trim.

C. Roof insulation.

D. Fasteners and attachment devices.

E. Coatings and slip sheets to isolate sheet metal from dissimilar materials.

1.02 RELATED SECTIONS

A. Section 061000 - Rough Carpentry

B. Section 076200 - Sheet Metal Flashing and Accessories: Flashing reglets and accessories.

C. Section 076200 - Sheet Metal Flashing and Accessories: Gutters and downspouts.

D. Division 26 - Electrical: Lightning Protection

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.

C. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges

D. ASCE 7 - Minimum Design Loads for Buildings and Other Structures

E. ASTM C 1289 - Standard for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

F. ASTM D 226 - Standard for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

G. ASTM E 84 - Standard for Surface Burning Characteristics of Building Materials.

H. ASTM E 283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

I. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

J. ASTM E 1592-01 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.

K. ASTM D 226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

L. ASTM E 1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.

M. ASTM E 1680 - Standard Test Method for Rate of Air Leakage Through Exterior Metal Roof Panel Systems.

N. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

A. Test Report submittal requirements:
   1. Air Infiltration (ASTM E 283): No evidence of uncontrolled leakage on seams at design wind load.
   2. Water Infiltration (ASTM E 331): No evidence of uncontrolled leakage on seams at design wind load.
   3. Wind Uplift: Based on Roof Section of Building Code in force in the jurisdiction of the project.

B. Shop Drawings and Calculations:
   1. Submit calculations prepared according to “Design Requirements.”
   2. Shop Drawings: Prepared specifically for this project; show dimensions of metal roofing and interface with other products indicating the extent of work to be performed. Include detailed drawings clearly indicating details of metal roofing component profiles, joints, transitions, slope changes, fastening methods, accessory items, and relationship of roofing materials to adjacent construction. Include sections of gutters, downspouts and roof detailing flashing and trim for different conditions. Show securement of panels and clips, spacing, type and number of fasteners as recommended by the manufacturer.
   3. If jurisdiction in the location of the project requires special tests or product certification, manufacturer shall certify that product has been approved for use in that jurisdiction.

C. Product Data: Manufacturer's technical information and installation instructions, in sufficient detail to demonstrate products comply with contract documents.

D. Samples:
   1. Submit two samples 4-inch square (100 x 100 mm) in size illustrating metal finish color.
   2. Submit two samples 12 x 12 inch (300 x 300 mm) in size illustrating metal finish and texture to be used in roofing work. Include seam with roof edge, and fasteners.

E. Manufacturer's certification that metal roofing components receive galvalume protective finish.

F. Submit manufacturer's warranty covering the substrate (metal) against failure due to normal atmospheric corrosion for 20 years. Submit manufacturer's 20-year warranty on finish. Submit contractors 2-year watertight warranty.

G. Submit manufacturer's certification that installing contractor is approved to install its product, and that their experience satisfies the requirements of these specifications.

H. Submit manufacturer's certification that the contract documents satisfy the requirements of their warranties.

1.06 ASSEMBLY DESCRIPTION

A. The roofing assembly includes preformed sheet metal panels, clips, ridge material, endlaps, flashings and attaching devices.

1.07 DESIGN REQUIREMENTS

A. Metal roof shall be engineered to withstand code required projected wind loads including uplift forces and other live and dead loads without exceeding the allowable design stress of the materials involved, including anchors and connections.
   1. Prepare wind uplift calculations sealed by a structural engineer registered in the state of the project. Calculations shall be based on design criteria in the Roofing Section of the Building code in force in the jurisdiction of the project, according to ASCE 7-2010, in accordance with recommendations of AISC, and according to supplemental design data provided in the documents, whichever is most stringent.

2. Identify uplift forces for field and edge conditions according to the geometry of the roof as required by the Roofing Section of the Building code in force in the jurisdiction of the project. Identify design criteria used in the calculations such as assumed safety factors, wind speed, etc.
3. Identify spacing and type of the fasteners and connectors for all uplift conditions.
4. Design safety factor as required by above regulations but not less than 2.

1.08 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise noted.

B. Installer Qualifications: Company specializing in performing sheet metal roof installations with minimum 5 years of experience.

C. Installer: A company familiar with installing products included in this section and which has completed at least 20 successful installations similar in scope to work included in this section.
   1. Installer must be approved by manufacturer to install its products.

D. Manufacturer: Company specializing in Architectural Sheet Metal Products with ten (10) years minimum experience.
   1. Manufacturer shall provide a representative to visit the site as required to assure correct installation, and at completion of installation for final inspection and certification that installation complies with requirements of watertight warranty.

E. Quality Standard:
   1. Fabricate and install metal roofing work in accordance with Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA) "Architectural Sheet Metal Manual," unless specifically indicated otherwise.

F. Engineering and Design:
   1. Provide manufacturer's certification of compliance with performance requirements in “Design Requirements.”
   2. Provide calculations as described in “Submittals.”

1.09 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, or abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Upon receipt of panels and other materials, installer shall examine the shipment for damage and completeness.

C. Prevent contact with materials that could cause discoloration or staining.

1.10 WARRANTY

A. Provide 20-year manufacturer warranty for Galvalume (R). Warranty shall include color fade, chalking, film integrity, and perforation.

B. Provide 20-year Kynar 500(R) limited finish warranty.

C. Manufacturer and Installer shall provide a written warranty for 20-year period from Date of Substantial Completion, guaranteeing materials and workmanship for watertightness, weathertightness and against all leaks. During the initial twenty (20) year period, the Installer shall assure weathertightness and watertightness of the roofing without any cost to the building Owner.
   1. Warranty shall be signed by manufacturer, installer, and Contractor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Corrugated Metal Roof Panel: Curved and Straight 'S' Deck Panels; Berridge Manufacturing Company, 1720 Maury, Houston, TX 77026; 800-231-8127.

B. Products of the following other manufacturers, provided they comply with requirements of the contract documents, will be among those considered acceptable:
   1. Architectural Roofing and Siding, Inc.
   2. Berridge Manufacturing Co.
   3. Petersen Aluminum Corporation
   4. Dimension Metals, Inc.

C. Provide all sheet metal roofing and accessories from a single manufacturer.

2.02 MATERIALS

A. Sheet metal roofing: Galvalume(R) by Bethlehem Steel Corporation: Cold-rolled steel sheet with factory-applied finish as follows; corrosion-resistant aluminum-zinc alloy coating, chromate pretreatment, primer, and finish coat.
   1. Gauge to be determined by manufacturer, but not less than SMACNA recommended, with baked on finish over Galvalume ASTM A-792, AZ55, 40 KSI yield point, 52 KSI tensile strength.

2.03 UNITS

A. Panel Construction: Panels shall be uniformly dimensioned, roll-formed to exact lengths to avoid trimming. Panels shall be continuous from ridge to eaves with no end laps. One side of the panel shall be female in configuration, suitable to accept the other male side, and form a locking assembly.

B. Corrugated Metal Roof Panel:
   1. Overall panel width to be 35", with 32" nominal coverage.
   2. 7/8" Corrugations to be spaced 2" on center.
   3. Panel-to-panel and panel-to-purlin connections to be with No. 12-14 self-drilling fasteners, 1" min. for panel-to-purlin connections, 3/4" minimum for panel-to-panel connections.
   4. Apply a line of tape sealant for weather tightness to be used at panel side laps and end laps.
   5. Panel assembly shall bear Underwriters Laboratories Label UL90.

2.04 PERFORMANCE

A. As a minimum requirement, metal panel system shall meet the requirements of Underwriter's Laboratories, Inc. for Class 90 wind uplift resistance.

B. Complete metal panel system shall have a maximum static pressure air infiltration of 0.046 cfm/ square foot with 1.57 psf air pressure differential when tested in accordance with ASTM E 283.

C. Complete metal roof system shall have no uncontrolled water penetration, other than condensation, when exposed to water at 6.24 psf differential static pressure when tested for not less then fifteen minutes in duration in accordance with ASTM E 331.

D. Entire roofing system (metal panels, flashing, expansion joints and penetrations) is to be detailed to provide watertight roof under peak weather conditions.

E. Panels shall display a flame-spread classification of a Class 1 when tested in accordance with ASTM E-84.

2.05 FINISHES

A. 2-3-4 Coat Kynar 500(R) Coating (PermaColor 2000): Preweathered Galvalume(R) coating, comprised of 0.8 to 0.9 mil full strength 70 percent Kynar 500(R) finish coating over 0.2 to 0.3 mil urethane primer.
   1. Coating Application: Top Side
   2. Reverse Side (Steel): Primer and washcoat.
   3. Color as selected by the Owner from the Manufacturer's standard colors.

2.06 ACCESSORIES

A. Z-Furring Members: Standard zee-shaped furring members with slotted or non-slotted web, fabricated from 24 gage steel sheet with hot-dip galvanized coating complying with ASTM A 653/A 653M, Coating Designation G60; to match insulation depth and with face flange and substrate attachment flanges of dimensions required for contract conditions

B. Fasteners: Corrosion resistant metal of same material as the material being fastened, or other material recommended by sheet metal manufacturer. Match finish and color of exposed fastener heads to finish and color of sheet material being fastened.

C. Sealant: Factory-applied seam sealant shall be non-curing butyl designed for metal-to-metal connection in concealed joints. Field applied sealant and/or butyl tape shall be as recommended by the manufacturer of the metal roof system.

D. Joint Adhesive: As recommended by metal manufacturer for sealing of nonmoving joints.

E. Underlayment: ASTM D 226, organic roofing felt, unperforated and ungranulated, Type II ("No.30").

F. Bituminous Coating: Heavy bodied, sulfur free, asphalt-based paint; FS TT-C-494.

G. Roof Insulation: The basis of design is AC Foam II by the Atlas Roofing Corp., a closed cell polyisocyanurate core integrally laminated to heavy black non asphaltic, fiberglass reinforced felt facers that complies with ASTM C 1289, Type II.
   1. Insulation Thickness: As shown on drawings.
   2. Manufacturers: Polyisocyanurate boards with facers meeting the requirements of these specifications and manufactured by one of the following will also be acceptable:
      a. Apache Products Co.
      b. GAF Materials Corp.
      c. RMax, Inc.
      d. Roofing Products Division, The Celotex Corp.

H. Slip Sheet: Rosin sized building paper.

I. Primer: Zinc molybdate type.

J. Protective Backing Paint: Zinc molybdate alkyd.

2.07 FABRICATION - SHEET METAL ROOFING

A. Panel Construction: Panels shall be uniformly dimensioned, roll-formed to exact lengths to avoid trimming. Panels shall be continuous from ridge to eaves with no end laps.

B. There shall be no face penetration of panels for securing panels to facilitate directional expansion/ contraction.

C. Standing seam design shall prevent water infiltration by utilizing a capillary break to prevent siphoning.

D. Factory fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, non-corrosive metal recommended by sheet metal manufacturer.

1. Gauge: As recommended by SMACNA or metal manufacturer for application, but in no case less than gauge of metal being secured.

E. All exposed adjacent flashing shall be of the same material and finsih as the roof panels.

F. Fabricate roofing components including pans, cleats, clips, expansion provisions, and flashing to match profiles and details indicated. Where details are not specifically indicated, comply with the SMACNA "Architectural Sheet Metal Manual" for metal roofing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive sheet metal roofing. Verify that substrate is uniform, even and symmetrical by running a string test.
   1. Notify the Architect and Owner in writing of any defective conditions encountered.
   2. Correct defective conditions before beginning work. Starting of work shall constitute acceptance of such conditions.

B. Inspect roof deck to verify deck is clean and smooth, free of depressions, waves, or projections, properly sloped to drains.

C. Verify correct placement of wood nailers and insulation positioning between nailers.

3.02 PREPARATION

A. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

B. Install starter and edge strips, and cleats before starting installation.

C. Install surface mounted reglets true to lines and levels. Seal top of reglets with sealant.

D. Coordinate sheet metal roofing with other sheet metal work and substrate construction to provide a complete and water-tight installation.

3.03 INSTALLATION - CORRUGATED METAL ROOF PANELS

A. Except as otherwise shown or specified, comply with recommendations and instructions of manufacturer of sheet metal roofing being fabricated and installed.

B. General: Comply with sheet metal manufacturer's installation methods and recommendations in the SMACNA "Architectural Sheet Metal Manual."

C. Install panels in such a manner that horizontal lines are true and level and vertical lines are plumb over a layer of 30 lb. felt with a minimum 6” for horizontal lap and 12” for end lap.

D. Install starter and edge trim before installing roof panels. Panels shall be continuous from ridge to eaves with no horizontal end laps. Do not expose field cuts to weather.

E. Attach panels using manufacturers standard clips and fasteners, spaced in accordance with approved shop drawings. No face penetrations or perforations shall be made in panels by fasteners without specific approval of the Owner.

F. Z-Furring Members and Roof Insulation: Coordinate installation of z-furring members, insulation and sheet metal roofing. Z-furring members to retain the roof insulation and to be secured to wood deck with specified fasteners of the number required for uplift requirements of metal roofing. (max. 24 inches on center)
   1. Do not allow fasteners to penetrate deck when deck is exposed below. Replace any wood deck damaged by penetration.

G. Provide in sheet metal flashing pre-punched holes larger than nail shank, smaller than nail head. Set nails to secure flashing without sinking head into metal to allow for thermal movement.

3.04 INSTALLATION - FLASHINGS

A. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

3.05 PROTECTION

A. Do not permit traffic over unprotected roof surface. If required, provide cushioned walk boards.

B. Remove protective film from prefinished metal immediately after installation.

C. Protect installed roof panels and trim from damage caused by adjacent construction.

D. Repair or replace work which is damaged or defaced, as directed by owner.
   1. Refinish marred and abraded areas of pre-finished sheet using finish manufacturer's recommended methods and materials. Replace units, which, in the opinion of the owner, cannot satisfactorily be refinished in place.

E. Remove from sheet metal surfaces any debris or substances, which will inhibit uniform weathering.

F. Protect sheet metal work as recommended by the installer so that completed work will be clean, secured, and without damage at substantial completion.

END OF SECTION

SECTION 076200

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fabricated sheet metal items, including copings, conductor head, fabricated sheet metal items, flashings, counterflashings.

B. Gutter and downspouts with accessories.

1.02 RELATED SECTIONS

A. Section 061000 - Rough Carpentry: Wood nailers and blocking for batten seams.

B. Section 073113 - Asphalt Shingles.

C. Section 076100 - Sheet Metal Roofing.

D. Section 076200 - Sheet Metal Flashing and Trim: Specialty gutters.

E. Section 077200 - Roof Accessories: Roof-mounted units.

F. Section 079200 - Joint Sealers.

G. Section 099000 - Painting and Coating: Field painting.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association.

C. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.

D. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.

E. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

F. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

G. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

H. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

I. ASTM D 226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

J. ASTM D 1970 - Specification for Self-Adhering Polymer Modified Bituminous Sheet Metals used as Steep Roofing Underlayment for Ice Dam Protection.

K. ASTM D 2178 - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.

L. ASTM D 4479 - Standard Specification for Asphalt Roof Coatings - Asbestos-Free.

M. ASTM D 4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.

N. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

A. Shop Drawings: Indicate material profile, type, gauge, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

B. Samples:

1. Submit two samples, 6 x 6 inch in size illustrating material of typical standing seam.
2. Samples: Submit four samples 2 x 2 inch in size illustrating metal finish color.

1.06 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.

B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 5 years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Prevent contact with materials that could cause discoloration or staining.

C. Coordinate the work of installing recessed flashing reglets with related wall construction.

PART 2 - PRODUCTS

2.01 SHEET MATERIALS

A. Galvanized Steel: ASTM A 653/A 653M, with G90/Z275 zinc coating; minimum 0.02 inch (0.6 mm) thick base metal.

B. Pre-Finished Galvanized Steel: ASTM A 653/A 653M, with G90/Z275 zinc coating; minimum 0.02 inch (0.6 mm) thick base metal, shop pre-coated with modified silicone coating.

1. Modified Silicone Polyester Coating: Pigmented Organic Coating System, AAMA 2603; baked enamel finish system; color as scheduled.
2. PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; color as scheduled.....

2.02 ACCESSORIES

A. Fasteners: Stainless steel, with soft neoprene washers.

B. Underlayment:

1. ASTM D 226, organic roof felt, Type l (No. 15).
   a. Carlisle / ”Dri-Start A”.
   b. WR Grace / “Ice and Water Shield”.
   c. Owens Corning / “Weatherlock”.

C. Slip Sheet: Rosin sized building paper.

D. Primer: Zinc chromate type.

E. Protective Backing Paint: Zinc chromate alkyd.

F. Sealant: Type as specified in Section 079200.

G. Plastic Cement: ASTM D 4586, Type I.

H. Solder: ASTM B 32; Sn50 (50/50) type.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Fabricate cleats of type sheet metal; or same material as sheet, interlocking with sheet.

C. Form pieces in longest possible lengths.

D. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.

E. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

F. Fabricate corners from one piece with minimum 18 inch (450 mm) long legs; seam for rigidity, seal with sealant.

G. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.

H. Pre-punch nailing flanges so hole is larger than nail shank but smaller than nail head.

I. All cleats shall be continuous.

2.04 GUTTERS AND DOWNSPOUT FABRICATION

A. Aluminum Sheet; ASTM B209 0.032 inch (0.8mm).

1. Pre-finish per ASTM B209 with Fluoropolymer coating, unless noted otherwise in drawings.
2. Refer to above for fluoropolymer coating requirements.

B. Gutter Profile: Refer to drawings.

1. If no profile is indicated, rectangular profile per SMACNA Architectural Sheet Metal Manual.

C. Downspout Profile: Refer to drawings.

1. If no profile is indicated, provide round profile.

D. Sizing: Size for rainfall intensity determined by a storm occurrence if 1 in 5 years in accordance with SMACNA.

E. Accessories: Profiled to suit gutters and downspouts.

1. Anchorage Devices: In accordance with SMACNA requirements.
2. Gutter Supports: Brackets.
3. Downspout Supports: Straps.

F. Splash Pads: Pre-cast concrete type; minimum 3000 psi at 28 days with minimum 5 percent air entrainment.

1. Provide at all downspouts not directly connected to storm piping.

G. Downspout Boots: Steel.

H. Seal metal joints.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.

B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil (0.4 mm).

3.03 INSTALLATION

A. Conform to drawing details and related SMACNA Architectural Sheet Metal Manual.

B. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

C. Insert flashings into reglets to form tight fit. Secure in place with lead wedges. Seal flashings into reglets with sealant.

D. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.

E. Apply plastic cement compound between metal flashing flanges and felt flashings.

F. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

G. Seal metal joints watertight.

H. Solder metal joints for full metal surface contact. After soldering, wash metal clean with neutralizing solution and rinse with water.

I. Secure gutters and downspouts in place using concealed fasteners.

J. Slope gutters 1/4 inch per foot (20 mm/m) minimum.

K. Connect downspouts to downspout boots. Grout connection watertight.

L. Set splash blocks under downspouts.

3.04 FIELD QUALITY CONTROL

A. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION

SECTION 078100

APPLIED FIREPROOFING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fireproofing of interior structural steel.

B. Fireproofing of exterior exposed structural steel.

C. Preparation of fireproofing for application of finish specified elsewhere.

1.02 RELATED REQUIREMENTS

A. Section 051200 - Structural Steel Framing.

B. Section 052100 - Steel Joist Framing.

C. Section 053100 - Steel Decking.

D. Section 078123 - Intumescent Fireproofing.

E. Section 078400 - Firestopping.

F. Section 092116 - Gypsum Board Assemblies: Gypsum board fireproofing.

1.03 REFERENCE STANDARDS

A. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010.

B. ASTM E 605 - Standard Test Methods for Thickness and Density of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2006).

C. ASTM E 736 - Standard Test Method For Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members; 2000 (Reapproved 2006).

D. ASTM E 759 - Standard Test Method for Effect of Deflection on Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2005).

E. ASTM E 760 - Standard Test Method for Effect of Impact on Bonding of Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2005).

F. ASTM E 761 - Standard Test Method for Compressive Strength of Sprayed Fire-Resistive Material Applied to Structural Members; 1992 (Reapproved 2005).

G. ASTM E 859 - Standard Test Method for Air Erosion of Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2006).

H. ASTM E 937 - Standard Test Method for Corrosion of Steel by Sprayed Fire-Resistive Material (SFRM) Applied to Structural Members; 1993 (Reapproved 2005).

I. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with placement of ceiling hanger tabs, mechanical component hangers, and electrical components.

B. Pre-installation Meeting: Convene two (2) weeks before starting work of this section.

1.05 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittals procedures.

B. Product Data: Provide data indicating product characteristics, performance criteria, and limitations of use.

C. Test Reports: Reports from reputable independent testing agencies for proposed products, indicating compliance with specified criteria, conducted under conditions similar to those on project, for:
   1. Bond Strength.
   2. Bond Impact.
   3. Density.
   4. Fire tests using substrate materials similar those on project.

D. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

E. Manufacturer's Certificate: Certify that sprayed-on fireproofing products meet or exceed requirements of contract documents.

F. Manufacturer's Field Reports: Indicate environmental conditions under which fireproofing materials were installed.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified in this section, and:
   1. Having minimum two years of documented experience.
   2. Approved by manufacturer.

1.07 MOCK-UP

A. Construct mock-up, 100 square feet (9 square meters) in size.

B. Conform to project requirements for fire ratings.

C. Locate where directed.

D. Examine installation within one hour of application to determine variances from specified requirements due to shrinkage, temperature, and humidity.

E. Where shrinkage and cracking are evident, adjust mixture and method of application as necessary. Remove materials and re-construct mock-up.

F. Mock-up may remain as part of the Work.

1.08 FIELD CONDITIONS

A. Do not apply spray fireproofing when temperature of substrate material and surrounding air is below 40 degrees F (4 degrees C).

B. Provide ventilation in areas to receive fireproofing during application and 24 hours afterward, to dry applied material.

C. Provide temporary enclosure to prevent spray from contaminating air.

D. Do not allow roof traffic during installation of roof fireproofing and drying period.

1.09 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.
   1. Include coverage for fireproofing to remain free from cracking, checking, dusting, flaking, spalling, separation, and blistering.
   2. Reinstall or repair failures that occur within warranty period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Sprayed-On Fireproofing:
   1. Carboline Company: www.carboline.com.
   2. Grace Construction Products: www.na.graceconstruction.com.
   3. Isolatek International Inc: www.isolatek.com.
   4. Southwest Fireproofing Products Company: www.sfrm.com.
   5. Substitutions: See Section 016000 - Product Requirements.

2.02 FIREPROOFING ASSEMBLIES

A. Provide assemblies as indicated on the drawings.

2.03 MATERIALS

A. Sprayed Fire-Resistive Material for Interior Applications: Manufacturer's standard factory mixed material, which when combined with water is capable of providing the indicated fire resistance, and conforming to the following requirements:
   1. Bond Strength: 150 psf (7.2 kPa), minimum, when tested in accordance with ASTM E 736 when set and dry.
   2. Dry Density: As required by fire resistance design.
   3. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E 760.
   4. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E 937.
   5. Air Erosion Resistance: Weight loss of 0.025 g/sq ft (0.27 g/sq m), maximum, when tested in accordance with ASTM E 859 after 24 hours.
   6. Surface Burning Characteristics: Maximum flame spread of 0 and maximum smoke developed of 0, when tested in accordance with ASTM E 84.
   7. Effect of Deflection: No cracking, spalling, or delamination, when tested in accordance with ASTM E 759.

B. Sprayed Fire-Resistive Material for Exterior Applications: Manufacturer's standard factory mixed material, which when combined with water is capable of providing the indicated fire resistance, and conforming to the following requirements:
   1. Recommended by manufacturer for permanent exterior exposure.
   2. Composition: Portland-cement-based, not mineral fiber-based.
   3. Bond Strength: 150 psf (7.2 kPa), minimum, when tested in accordance with ASTM E 736 when set and dry.
   4. Dry Density: As required by fire resistance design.
   5. Effect of Impact on Bonding: No cracking, spalling or delamination, when tested in accordance with ASTM E 760.
   6. Corrosivity: No evidence of corrosion, when tested in accordance with ASTM E 937.
   7. Air Erosion Resistance: Weight loss of 0.025 g/sq ft (0.27 g/sq m), maximum, when tested in accordance with ASTM E 859 after 24 hours.
   8. Surface Burning Characteristics: Maximum flame spread of 0 and maximum smoke developed of 0, when tested in accordance with ASTM E 84.

2.04 ACCESSORIES

A. Primer Adhesive: Of type recommended by fireproofing manufacturer.

B. Overcoat: As recommended by manufacturer of fireproofing material.

C. Metal Lath: Expanded metal lath; 3.4 lb/sq ft (16 kg/sq m), galvanized finish.

D. Water: Clean, potable.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive fireproofing.

B. Verify that clips, hangers, supports, sleeves, and other items required to penetrate fireproofing are in place.

C. Verify that ducts, piping, equipment, or other items that would interfere with application of fireproofing have not been installed.

D. Verify that voids and cracks in substrate have been filled. Verify that projections have been removed where fireproofing will be exposed to view as a finish material.

3.02 PREPARATION

A. Perform tests as recommended by fireproofing manufacturer in situations where adhesion of fireproofing to substrate is in question.

B. Remove incompatible materials that could affect bond by scraping, brushing, scrubbing, or sandblasting.

C. Prepare substrates to receive fireproofing in strict accordance with instructions of fireproofing manufacturer.

D. Apply fireproofing manufacturer's recommended bonding agent on primed steel.

E. Protect surfaces not scheduled for fireproofing and equipment from damage by overspray, fall-out, and dusting.

F. Close off and seal duct work in areas where fireproofing is being applied.

3.03 APPLICATION

A. Install metal lath over structural members as indicated or as required by UL Assembly Design Numbers.

B. Apply primer adhesive in accordance with manufacturer's instructions.

C. Apply fireproofing in thickness and density necessary to achieve required ratings, with uniform density and texture.

D. In exposed locations, trowel surface smooth and form square edges, using tools and procedures recommended by fireproofing manufacturer.

E. Apply overcoat at the rate recommended by fireproofing manufacturer.

3.04 FIELD QUALITY CONTROL

A. Inspect the installed fireproofing after application and curing for integrity, prior to its concealment. Ensure that actual thicknesses, densities, and bond strengths meet requirements for specified ratings.

B. Re-inspect the installed fireproofing for integrity of fire protection, after installation of subsequent Work.

3.05 CLEANING

A. Remove excess material, overspray, droppings, and debris.

B. Remove fireproofing from materials and surfaces not required to be fireproofed.

C. At exposed fireproofing, clean surfaces that have become soiled or stained, using manufacturer's recommended procedures.

END OF SECTION

SECTION 078123

INTUMESCENT MASTIC FIREPROOFING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Thin-film intumescent fire-resistive coating for exposed interior structural steel.

B. Decorative topcoat.

1.02 RELATED REQUIREMENTS

A. Section 051200 - Structural Steel Framing.

B. Section 052100 - Steel Joist Framing.

C. Section 078100 - Applied Fireproofing: Conventional cementitious and mineral fiber fireproofing.

D. Section 099000 - Painting and Coating: Field-applied paints matching intumescent fireproofing.

1.03 REFERENCE STANDARDS

A. ASTM D 2240 - Standard Test Method for Rubber Property -- Durometer Hardness; 2005.

B. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2010.

C. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2009c.

D. SSPC-PA 2 - Measurement of Dry Coating Thickness with Magnetic Gages; 2004.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittals procedures.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Performance characteristics and test results.
   2. Preparation instructions and recommendations.
   3. Storage and handling requirements and recommendations.
   4. Installation methods.

C. Selection Samples: For decorative top coat, color chips representing manufacturer's full range of available colors and sheens.

D. Verification Samples: For each thickness, color, sheen, and finish required, samples not less than 4 inches (100 mm) square on steel substrate, illustrating finished appearance.

E. Test Reports: Published fire-resistive designs for structural elements of the types required for the project, indicating hourly ratings of each assembly.

F. Certificates: Certify that intumescent fireproofing provided for this project meets or exceeds specified requirements in all respects.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company that specializes in manufacturing the type of products specified, with minimum of 10 years of documented experience.

B. Installer Qualifications: Approved, certified, or supervised by manufacturer of intumescent fireproofing, with not less than 5 years of documented experience.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship. Approved mock-up will serve as a standard of comparison for subsequent work of this section.
   1. Finish at least 100 sq ft (10 sq m) of steel in areas designated by Architect.
   2. Evaluate mock-up for compliance with specified requirements, including thickness and finish texture.
   3. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
   4. Refinish mock-up area as required to produce acceptable work.
   5. Approved mock-up may remain as part of the project.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers with identification labels and testing agency markings intact and legible.

B. Store products in manufacturer's unopened packaging until ready for installation.
   1. Store at temperatures not less than 50 degrees F (10 degrees C) in dry, protected area.
   2. Protect from freezing, and do not store in direct sunlight.
   3. Dispose of any materials that have come into contact with contaminants of any kind prior to application.

C. Dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.07 FIELD CONDITIONS

A. Protect areas of application from windblown dust and rain.

B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
   1. Provide temporary enclosures as required to control environmental conditions.
   2. Do not apply intumescent fireproofing when ambient temperatures are below 50 degrees F (10 degrees C) without specific approval from manufacturer.
   3. Maintain relative humidity between 40 and 60 percent in areas of application.
   4. Maintain ventilation in enclosed spaces during application and for not less than 72 hours afterward.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Intumescent Fireproofing:
   1. Albi Manufacturing Division of StanChem Inc: www.albi.com.
   2. Carboline Company: www.carboline.com.
   3. Isolatek International; CAFCO SprayFilm WB5 5 (interior): www.isolatek.com.
   4. Substitutions: See Section 016000 - Product Requirements.

2.02 SYSTEM REQUIREMENTS

A. Fireproofing: Provide intumescent thin-film fire-resistive coating systems tested by an independent testing agency in accordance with ASTM E 119 and acceptable to authorities having jurisdiction.
   1. Provide assemblies listed by UL or FM.

2.03 MATERIALS

A. Interior Fire-Resistive Coating System: Water-based, asbestos-free, factory-mixed thin film intumescent coating system with smooth and uniform finish texture.

1. Surface Burning Characteristics, when tested in accordance with ASTM E 84:
   a. Smoke Developed Index: 50, maximum.
2. Hardness: 80, minimum, when tested in accordance with ASTM D 2240, Type D durometer.
3. Density: 11.4 lb/gallon (1.37 kg/L), minimum.

B. Protective and Decorative Top Coating: As recommended by fireproofing manufacturer for exposure conditions.
   1. Color and Gloss: As scheduled.
   2. Coordinate with paint specified in Section 099000 for color and sheen match between steel coated with intumescent coating and adjacent painted surfaces.

C. Primer: As required by tested and listed assemblies, and as recommended by fireproofing manufacturer to suit specific substrate conditions.

D. Reinforcement: Glass fiber fabric matching type used in tested and listed assemblies.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates to determine if they are in satisfactory condition to receive intumescent fireproofing. Verify that they are clean and free of oil, grease, incompatible primers, or other foreign substances capable of impairing bond to fireproofing system.

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

3.02 PREPARATION

A. Thoroughly clean surfaces to receive fireproofing.

B. Repair substrates to remove surface imperfections that could affect uniformity of texture and thickness of fireproofing system. Remove minor projections and fill voids that could telegraph through the finished work.

C. Cover or otherwise protect other work that might be damaged by fallout or overspray of fireproofing system. Provide temporary enclosures as necessary to confine operations and maintain required environmental conditions.

3.03 INSTALLATION

A. Comply with manufacturer's instructions for particular conditions of installation in each case.

B. Apply manufacturer’s recommended primer to required coating thickness.

C. Apply fireproofing to full thickness over entire area of each substrate to be protected. Apply coats at manufacturer’s recommended rate to achieve dry film thickness required for fire resistance ratings designated for each condition.

D. Apply intumescent fireproofing by spraying to maximum extent possible. If necessary, complete coverage by roller application or other method acceptable to manufacturer.

E. Achieve uniform finished appearance complying with approved mock-up.

3.04 FIELD QUALITY CONTROL

A. Perform field inspection and testing in accordance with Section 014000.
   1. Arrange for testing of installed intumescent fireproofing by an independent testing laboratory using magnetic thickness gage, in accordance with SSPC-PA 2.
   2. Submit test reports promptly to Contractor and Architect.

B. Repair or replace fireproofing at locations where test results indicate fireproofing does not meet specified requirements.

3.05 CLEANING

A. Immediately after installation of fireproofing in each area, remove overspray and fallout from other surfaces and clean soiled areas.

3.06 PROTECTION

A. Protect installed intumescent fireproofing from damage due to subsequent construction activities, so fireproofing is without damage or deterioration at time of Substantial Completion.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 078400

FIRESTOPPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fire safing penetrations through fire barriers,

B. Extent of fire barriers as shown on Drawings.

C. Work Not Included: Repairing penetrations made in error and repairing penetrations which are too large to be sealed by the methods indicated; these are to be repaired using the original material of the construction under the work of the appropriate sections.

D. Products Furnished but Not Installed:
   1. Sleeves which are an integral part of the fire safing assembly but which must be set by installer of other construction.

E. Firestopping of all joints and penetrations in fire-resistance rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED SECTIONS

A. Section 078100 - Applied Fireproofing.

B. Section 092116 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

C. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.

D. FM P7825 - Approval Guide; Factory Mutual Research Corporation.

E. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.

1.04 DEFINITIONS

A. Fire Barrier: Any wall, floor, ceiling, or roof which is indicated as having a fire resistance rating.

1.05 SUBMITTALS

A. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number, identification of penetration seal to be used, fire rating of penetration seal, and evidence of acceptable testing.

B. Product Data: Provide data on product characteristics, performance ratings, and limitations.

C. Maintenance Data: Include detailed instructions for repair and for modification due to changes in penetrating items.

D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Qualification statements for installing mechanics.

1.06 QUALITY ASSURANCE

G. Testing Requirements: Testing shall have been conducted or witnessed by an independent testing agency acceptable to governing authorities.

1. Test Method: ASTM E 119 or ASTM E 814.
2. Conduct tests with a measurably higher pressure inside the chamber than outside.
3. The listing of the assembly to be used in the current edition of one of the following classification guides will be considered evidence of acceptable testing:
    a. Underwriters Laboratories Inc. "Fire Resistance Directory".

H. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

I. Installer Qualifications: Company specializing in performing the work of this section and:
1. With minimum 3 years documented experience installing work of this type.
2. Able to show at least 5 satisfactorily completed projects of comparable size and type.
3. Licensed by authority having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of products to minimize storage time at site.

B. Deliver products to project site in original unopened containers bearing the name of the manufacturer, product name, type, and testing agency's identification mark.

C. Store products in accordance with manufacturer's instructions.

1.07 SEQUENCING AND SCHEDULING

A. Perform fire safing work after completion of work which penetrates fire barriers, but prior to covering up or eliminating access to the penetration. Coordinate with installers of such other work.

1.08 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 - PRODUCTS

2.01 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements.
1. Fire Ratings: See Drawings for required systems and ratings.
2. All penetrations to meet UL systems for appropriate penetration types.

2.02 MATERIALS

A. Perimeter Firesafing Materials:
1. Product/Manufacturer:
    a. Thermafiber” Mineral Fiber Safing Insulation, foil faced; manufactured by Thermafiber, Inc., 3711 Mill St.; Wabash, IN 46992; phone: 888-834-2371 or 260-563-2111; Fax: 260-563-8979; Website: www.thermafiber.com.
    b. Other manufacturer's products complying with design and quality established by the system shown in drawings.
    c. Provide manufacturer's galvanized safing clips.
    d. Provide all accessory materials as required for complete installation of assembly to satisfy requirements of system shown in drawings.

B. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
1. Manufacturers:
    a. 3M Fire Protection Products www.3m.com/firestop

b. Hilti, Inc.; www.us.hilti.com
c. Specified Technologies, Inc.; www.stifirestop.com
d. Substitutions: See Section 016000 – Product Requirements

C. Intumescent Putty: Compound that expands on exposure to surface heat gain; conforming to the following:
1. Potential Expansion: Minimum 1000 percent.
2. Durability and Longevity: Permanent.
3. Color: Black, dark gray, to be chosen by Architect.
4. Manufacturers:
a. Grace Construction Products: www.na.graceconstruction.com.
b. 3M Fire Protection Products: www.3m.com/firestop.
c. Hilti, Inc.: www.us.hilti.com.
d. Specified Technologies, Inc.: www.stifirestop.com.
e. Substitutions: See Section 016000 - Product Requirements.

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

PART 3 - EXECUTION

3.01 EXAMINATION

A. Pre-installation inspection: Inspect all fire barriers for penetrations of any type; mark or otherwise identify all penetrations indicating action required: 1) repair; or 2) fire safing.
1. Conduct inspection prior to covering up or enclosing walls or ceilings.

B. If the configuration of a particular penetration does not conform to the configuration necessary for the required fire safing assembly, notify the installer of the penetration for modification of the configuration to suit the assembly; do not use the fire safing assembly in other configurations except as specifically stated in the test report or as approved by the authority having jurisdiction.

3.02 PREPARATION

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter which may affect bond of firestopping material per material manufacturer's instructions.

B. Remove incompatible materials that could adversely affect bond.

C. Install backing materials to arrest liquid material leakage.

3.03 INSTALLATION

A. Install materials in exact manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings; provide all accessory material required.

B. Remove combustible forming materials, unless they are a required component of the tested assembly.

C. Do not cover installed firestopping until inspected by authority having jurisdiction.

D. Install labeling required by code.

3.04 CLEANING

A. Clean adjacent surfaces of firestopping materials.

3.05 FIELD QUALITY CONTROL

A. Inspect completed installations for completeness and correct installation.
1. If installed work is to be covered in completed work, inspect prior to covering.

3.06 CLEANING

A. Clean up excess material adjacent to penetrations promptly; use methods and materials approved by the manufacturers of the penetration seals and of surfaces to be cleaned.

3.07 PROTECTION

A. Protect installed work during curing period.

B. Protect installed work from damage from construction operations using substantial barriers if necessary.

C. Repair damaged materials in accordance with manufacturer's instructions.

END OF SECTION

SECTION 079200

JOINT SEALANTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Wall joints.

B. Coping joints.

C. Joints around perimeter of frames.

D. Joints in floors and pedestrian paving.

E. Joints shown on Drawings.

F. Joints of a nature similar to that of joints shown on Drawings shall be sealed with same sealer, whether indicated on drawings to be sealed or not.

G. Sealant Backer.

1.02 RELATED SECTIONS

A. Section 033000 - Cast-in-place concrete.

B. Section 064000 – Architectural Woodwork.

C. Section 061166 - Solid Surfacing Fabrications: Countertops.

D. Section 072500 - Weather Barriers: Sealants required by air barriers and vapor retarders.

E. Section 074646 - Fiber Cement Siding.

F. Section 076200 - Sheet Metal Flashing and Trim.

G. Section 078400 - Firestopping: Fire stopping sealants.

H. Section 089100 - Louvers.

I. Division 23: Mechanical.

J. Division 26: Electrical.

K. Section 321300 - Concrete Paving.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM C 834 - Standard Specification for Latex Sealants.

C. ASTM C 919 - Standard Practice for Use of Sealants in Acoustical Applications.

D. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants.

E. ASTM C 1193 - Standard Guide for Use of Joint Sealants.

F. ASTM D 1667 - Standard Specification for Flexible Cellular Materials—Poly (Vinyl Chloride) Foam (Closed-Cell).

1.04 SUBMITTALS

A. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, and substrate preparation, limitations.

B. Samples: Submit four (4) cured samples, illustrating manufacturer's full range of sealant colors for selection. Required for products exposed to view only.

C. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

1.05 QUALITY ASSURANCE

A. Deliver materials in original containers or bundles with labels showing manufacturer, product name or designation, color, shelf life, and installation instructions.

B. Maintain one copy of each referenced document covering installation requirements on site.

C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

D. Applicator Qualifications: Company specializing in performing the work of this section with minimum three years' experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original containers or bundles with labels showing manufacturer, product name or designation, color, shelf life, and installation instructions.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Do not install sealers if any of the following conditions exist:
   1. Air or substrate temperature exceeds the range recommended by sealer manufacturers.
   2. Substrate is wet or damp.

B. Dimensional Limitations: Do not install sealers if joint dimensions are less than or greater than that recommended by sealer manufacturer; notify the owner and get sealer manufacturer's recommendations for alternative procedures.

1.08 WARRANTY

A. Submit a written warranty signed by the contractor guaranteeing to correct failures in sealer work that occur within 5 years after substantial completion, without reducing or otherwise limiting any other rights to correction which the owner may have under the contract documents. Failure is defined as failure to remain weathertight due to faulty materials or workmanship. Correction is limited to replacement of sealers.

PART 2 - PRODUCTS

2.01 MATERIALS - GENERAL

A. General: Provide only products which are recommended and approved by their manufacturer for the specific use to which they are put and which comply with all requirements of the contract documents.
   1. For each generic product, use only materials from one manufacturer.
   2. Provide only materials which are compatible with each other and with joint substrates.
   3. Colors of exposed sealers: As selected by the owner from manufacturer's standard colors.

B. Products: The design is based on the product(s) listed for each generic type. Comparable products of the other manufacturers will be considered for substitution.

2.02 ELASTOMERIC SEALANTS

A. General: Chemically curing elastomeric sealants of types indicated, complying with ASTM C 920, including specific Type, Grade, Class, and Uses indicated, as well as all other requirements specified.

B. Type S - Elastomeric Sealant: Single-Part Non-sag Low-Modulus Polyurethane Sealant; ASTM C 920, Grade NS, Class 25, Uses NT; single component.
   1. Color: Standard colors matching finished surfaces as selected by Architect.
   2. Products:
      a. "Dynatrol I"; Pecora Corporation
      b. "Sikaflex 1a"; Sika Corporation
      c. "Dymonic FC"; Tremco, Inc.
   3. Project Use: Building exterior joints and building interior joints in wet areas.
      a. Control, expansion, and soft joints in masonry.
      b. Joints between concrete and other materials.
      c. Joints between metal frames and other materials.
      d. Other exterior joints for which no other sealant is indicated.

C. Type M - Multipart Pourable Urethane Sealant: Grade P, Class 25, Use T.
   1. Products:
      a. "Vulkem 45SSL"; Tremco, Inc.
      b. "Urexpan NR-300"; Pecora Corporation
      c. "Sikaflex 2c SL"; Sika Corporation
      d. "Sonolastic SL 2"; Sonneborn Building Products/ChemRex, Inc.
      e. "THC-900"; Tremco, Inc.
      f. "Pourthane"; W. R. Meadows, Inc.
   2. Project Use: Concrete pavement joints, concrete floor joints, and steel railing posts/concrete joints.

2.03 LATEX SEALANTS

A. Acrylic-Latex Emulsion Sealant: One-part, non-sag, mildew-resistant, paintable; complying with ASTM C 834.
   1. Products:
      a. "AC-20"; Pecora Corporation
      b. "Sonolac"; Sonneborn Building Products Division/ChemRex, Inc.
      c. "Tremco Acrylic Latex 834"; Tremco, Inc.
   2. Color: Standard colors matching finished surfaces and selected by Architect.
   3. Applications: Use for:
      a. Interior wall and ceiling control joints.
      b. Joints between door and window frames and wall surfaces.
      c. Interior joints in non-wet areas.
      d. Other interior joints for which no other type of sealant is indicated.

B. Bathtub/Tile Sealant: White silicone; ASTM C 920, Uses I, M and A; single component, mildew resistant.
   1. Applications: Use for:
      a. Joints between plumbing fixtures and floor and wall surfaces.
      b. Joints between kitchen and bath countertops and wall surfaces.

C. Acoustical Sealant: Butyl or acrylic sealant; ASTM C 920, Grade NS, Class 12-1/2, Uses M and A; single component, solvent release curing, non-skinning.
   1. Applications: Use for concealed locations only:
      a. Sealant bead between top stud runner and structure and between bottom stud track and floor.

D. Concrete Paving Joint Sealant: Polyurethane, self-leveling; ASTM C 920, Class 25, Uses T, I, M and A; single component.
   1. To be used as back of house areas only. Color: Gray.
   2. Applications: Use for:
      a. Joints in sidewalks and vehicular paving.

2.04 SEALANT BACKERS

A. Backers - General: Non-staining; recommended or approved by sealant manufacturer for specific use.

B. Backer Rods: Flexible, non-absorbent, compressible polyurethane foam, either open-cell or non-gassing closed-cell, unless otherwise restricted by sealant manufacturer; preformed to appropriate size and shape.

2.05 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

E. Tooling Agents: Approved by sealant manufacturer; non-staining to sealant and substrate.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces and joint openings are ready to receive work.

B. Do not begin sealer work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Cleaning: Just before starting sealer installation, clean out joints in accord with recommendations of sealer manufacturers and as follows:
   1. Remove all materials that could impair adhesion, including dust, dirt, coatings, paint, oil, and grease. Exception: Materials tested to show acceptable adhesion and compatibility.
   2. Dry out damp and wet substrates thoroughly.
   3. Clean M-type and O-type substrates by suitable mechanical or chemical methods.
   4. Remove loose particles by vacuuming or by blowing with oil-free compressed air.
   5. Concrete: Remove laitance and form-release coatings.
   6. Clean and prime joints in accordance with manufacturer's instructions.
   7. Perform preparation in accordance with manufacturer's instructions and ASTM C 1193.
   8. Protect elements surrounding the work of this section from damage or disfigurement.
   9. Clean A-type and G-type substrates by chemical or other methods which will not damage substrate.
   10. Use methods which will not leave residues that will impair adhesion.

B. Priming: Prime substrates as recommended by sealer manufacturer.

C. Masking Tape: Use masking tape to keep primers and sealers off of adjacent surfaces which would be damaged by contact or by cleanup. Remove tape as soon as practical.

D. Install fillers where needed to provide proper joint depth or support for sealant backers.

3.03 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions except where more restrictive requirements are specified.

B. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

C. Elastomeric Sealants: Comply with recommendations of ASTM C 920.

D. Latex Sealants: Comply with recommendations of ASTM C 834.

E. Perform acoustical sealant application work in accordance with ASTM C 919.

F. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.

G. Backers:
   1. Install backers at depth required to result in shape and depth of installed sealant which allows the most joint movement without failure.
      a. Make backers continuous, without gaps, tears, or punctures.
      b. Do not stretch or twist backers.
   2. If backers become wet or damp before installation of sealant, dry out thoroughly before proceeding.

H. Sealants: Use methods recommended by manufacturer; completely fill the joint; make full contact with bond surfaces; tool non-sag sealants to smooth surface eliminating air pockets.
   1. Use concave joint shape shown in Figure 6A in ASTM C 962, where not otherwise indicated.
   2. Surface of sealant for joints in Portland cement concrete paving to be recessed 1/4-inch.

I. Pre-compressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch (3 to 6 mm) below adjoining surface.

J. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal all joints with adhesive; install with face 1/8 to 1/4 inch (3 to 6 mm) below adjoining surface.

3.04 PROTECTION AND CLEANING

A. Clean surfaces adjacent to joints as work progresses and before sealants set using methods and materials approved by manufacturers of sealers and of surfaces to be cleaned.

B. Protect joint sealers from contamination and damage.

C. Protect sealants until cured.

D. Remove and replaced damaged sealers.

END OF SECTION

SECTION 081110

METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Non-fire-rated steel doors and frames.

B. Fire-rated steel doors and frames.

C. Thermally insulated steel doors.

1.02 RELATED SECTIONS

A. Section 010400 - Accessibility for Persons with Disabilities

B. Section 079200 - Joint Sealants.

C. Section 087100 - Door Hardware.

D. Section 099000 - Paints and Coatings: Field painting.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ANSI/ICC A117.1 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council.

C. ANSI A250.3 - Test Procedure and Acceptance Criteria for Factory-Applied Finish Painted Steel Surfaces for Steel Doors and Frames.

D. ANSI A250.8 - SDI-100 Recommended Specifications for Standard Steel Doors and Frames.

E. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.

F. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

G. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.

H. DHI A115 Series - Specifications for Steel Doors and Frame Preparation for Hardware; Door and Hardware Institute (ANSI/DHI A115 Series).

I. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers.

J. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.

K. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.

L. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.

1.04 SUBMITTALS

A. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.

B. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.

C. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

B. Maintain at the project site a copy of all reference standards dealing with installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in accordance with NAAMM HMMA 840.

B. Deliver products in crates or cartons suitable for storage at site.

C. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

D. Replace items damaged in delivery, unless damage is minor and can be repaired to match intact items, as determined by Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Steel Doors and Frames:
1. Amweld Building Products. Inc.: www.amweld.com.
2. Ceco Door Products: www.cecodoor.com.
3. Windsor Republic Doors: www.republicdoor.com.
4. Steelcraft: www.steelcraft.com.
5. Kewanee Corporation
6. Mesker Door, Inc.: www.meskerdoor.com.
7. Substitutions: See Section 016000 - Product Requirements.

2.02 DOORS AND FRAMES

A. Requirements for All Doors and Frames:
1. Accessibility: Comply with 2010 ADA.
2. Steel Sheets, Hot-Rolled: ASTM A 569 and ASTM A 568, commercial quality, pickled and oiled.
3. Steel Sheets, Cold-Rolled: ASTM A 366 and ASTM A 568, commercial quality, matte finish exposed, oiled.
4. Steel Sheets, Galvanized: ASTM A 653 and ASTM A924, commercial quality, G60 zinc coating, mill phosphated.
5. Door Top Closures: Flush with top of faces and edges. Reinforce tops and bottoms of all doors with a continuous steel channel not less than 16-gage, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel shall have a steel closure channel welded in place so the web of the channel is flush with the top of the face sheets of the door.
6. Door Edge Profile: Beveled on both edges.
7. Door Texture: Smooth faces.
8. Hardware Preparation: In accordance with DHI A115 Series, with reinforcement welded in place, in addition to other requirements specified in door grade standard. Hinge reinforcement to be not less than 7 gage (3/16") plate 1-1/4" X 9". Approved equal is a 12-gage continuous channel with formed holes drilled and tapped. The manufacturer is to provide test information with submittal that this type reinforcement is equal to a 3/16" or 7 gage plate reinforcement.

9. Galvanizing for Units in Wet Areas and All Exterior Doors: All components hot-dipped zinc-iron alloy-coated (galvannealed), manufacturer's standard coating thickness.
10. Finish: Factory primed, for field finishing.

B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 STEEL DOORS

A. Exterior Doors Type Flush
1. Grade: ANSI A250.8 Level 3, physical performance Level A. Model 2, seamless.
2. Core: Vertical steel stiffeners and fiberglass. Provide 20-gauge vertical steel stiffeners spanning the full thickness of the interior space between door faces, spaced no more than 6 inches apart and attached by spot welds at no more than 5 inches on centers. Spaces between stiffeners shall be filled with fiberglass insulation (Min density 0.8#/cubic ft.)
3. Top Closures for Out-Swinging Doors: Flush with top of faces and edges.
4. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A 653/A 653M,
5. Texture: Smooth faces.
6. Insulating Value: U-value of 0.10, when tested in accordance with ASTM C 1363
7. Weatherstripping and thresholds: Separate, see Section 087100.
8. Finish: Factory primed, for field finishing unless noted otherwise on drawings.

B. Interior Doors, Non-Fire-Rated:
1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 2, seamless.
2. Core: Polyurethane or fiberglass insulation
3. Thickness: 1-3/4 inches (44 mm).
4. Texture: Smooth faces.
5. Finish: Factory primed, for field finishing.

C. Interior Doors, Fire-Rated:
1. Grade: ANSI A250.8 Level 2, physical performance Level B, Model 1, full flush.
2. Fire Rating: As indicated on Door and Frame Schedule, tested in accordance with UL 10C ("positive pressure").
   a. Provide units listed and labeled by UL.
   b. Attach or stamp fire rating label to each fire rated unit.
3. Smoke and Draft Control Doors Refer to schedule for locations: In addition to required fire rating, provide door assemblies tested in accordance with UL 1784 with maximum air leakage of 3.0 cfm per sq ft (0.01524 cu m/s/sq m) of door opening at 0.10 inch w.g. (24.9 Pa) pressure at both ambient and elevated temperatures; with "S" label; if necessary, provide additional gasketing or edge sealing.
4. Core: Mineral fiberboard.
5. Texture: Smooth faces.
6. Finish: Factory primed, for field finishing.

2.04 STEEL FRAMES

A. General:
1. Comply with the requirements of grade specified for corresponding door.
   a. ANSI A250.8 Level 2 Doors: 16 gage frames.
   b. ANSI A250.8 Level 3 Doors: 14 gage frames.
   c. Frames for Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 1, 18-gage.
2. Finish: Same as for door.

3. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
4. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches (100 mm) high to fill opening without cutting masonry units.
5. Frames Wider than 48 Inches (1200 mm): Reinforce with steel channel fitted tightly into frame head, flush with top.
6. Frames Installed Back-to-Back: Reinforce with steel channels anchored to floor and overhead structure.
7. Frames in metal stud and gypsum board partitions: Size to suit opening, with 2-inch high head frame, wrap around condition.
8. Guards: Weld protective covers to back of hardware openings at locations where grout, plaster, or other materials might interfere with hardware operation.

B. Exterior Door Frames: Fully welded.
1. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A 653/A 653M, with manufacturer's standard coating thickness.
2. Finish: Factory primed for field finishing.
3. Weatherstripping: Separate, see Section 087100.

C. Interior Door Frames, Non-Fire-Rated: Fully welded type.
1. Finish: Factory primed for field finishing unless noted otherwise.

D. Interior Door Frames, Fire-Rated: Fully welded type.
1. Fire Rating: Same as door, labeled.
2. Finish: Factory primed for field finishing unless noted otherwise.

E. Transom Bars: Fixed, of profile same as jamb and head.

F. Frames shall be mortised, reinforced, drilled and tapped at the factory for template mortised hardware only, in accordance with approved hardware schedule and template provided by the hardware contractor. Where surface mounted hardware is to be applied, frames shall have reinforcing plates only; all drilling and tapping to be done in the field by others.

G. Anchors for stud partitions to be steel of a suitable design, not less than 18 gage thickness,

H. All frames that are to be welded shall have a steel spreader during shipping and handling. Spreader bars are for bracing only and shall not be used to size the frame opening.

2.05 ACCESSORY MATERIALS

A. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.

B. Astragals for Double Doors: Specified in Section 087100.
1. Exterior Doors: Steel, Z-shaped.
2. Fire-Rated Doors: Steel, shape as required to accomplish fire rating.

C. Grout for Frames: Portland cement grout of maximum 4-inch slump for hand troweling; thinner pumpable grout is prohibited.

D. Bituminous Coating: at frames to be installed in masonry or to be grouted.

E. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion, of pairs, and 2 on head of pairs without center mullions, none if weatherstripping provided.

F. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

2.06 FINISH MATERIALS

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

2.07 FABRICATION

A. General: Shop fabricate assemblies to greatest extent possible, assuring that installed units will be without warp, twist, bow, or other defect in appearance or function.

B. Exposed Screws and Bolts: Where required, provide only countersunk, flat Phillips head fasteners.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that opening sizes and tolerances are acceptable.

3.02 PREPARATION

A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 INSTALLATION

A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.

B. In addition, install fire rated units in accordance with NFPA 80.

C. Coordinate frame anchor placement with wall construction.
   1. Portions of frames, which are unexposed in the finish work, are to receive the intermediate coat of specified paint system for interior ferrous metal prior to installation. Refer to painting systems in Division 9.
      a. Place welded frames prior to construction of enclosing elements, braced securely to achieve plumb, planar installation. Remove braces after anchorages have achieved final set, leaving frames in smooth, undamaged condition.
      b. Anchors: Provide 3 wall anchors per jamb at hinge and strike levels and minimum 18 gage base anchors

D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

E. Coordinate installation of hardware.

F. Coordinate installation of electrical connections to electrical hardware items.

G. Touch up damaged factory finishes.

3.04 TOLERANCES

A. Clearances between Door and Frame: As specified in ANSI A250.8.

B. Maximum Diagonal Distortion: 1/16 in (1.5 mm) measured with straight edge, corner to corner.

3.05 ADJUSTING

A. Adjust for smooth and balanced door movement.

3.06 SCHEDULE

A. Refer to Door and Frame Schedule on the Drawings.

END OF SECTION

SECTION 081613

FIBERGLASS DOORS AND FRAMES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fiberglass reinforced plastic (FRP) doors.

B. Frames for fiberglass reinforced plastic doors.

C. Accessories.

1.02 RELATED SECTIONS

A. Section 061000 - Rough Carpentry: Wood blocking.

B. Section 087100 - Door Hardware: Door hardware.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ANSI A250.4 - American National Standard Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors and Hardware Reinforcings.

C. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

D. ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

E. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Obtain hardware templates from hardware manufacturer prior to starting fabrication.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard details, installation instructions, and hardware and anchor recommendations.

B. Shop Drawings: Show layout and profiles; include assembly methods.
   1. Indicate product components, including hardware reinforcement locations and preparations, accessories, finish colors, patterns, and textures.
   2. Indicate wall conditions, door and frame elevations, sections, materials, gages, finishes, location of door hardware by dimension, and details of openings; use same reference numbers indicated on Drawings to identify details and openings.

C. Selection Samples: Submit two complete sets of color chips, illustrating manufacturer's available finishes, colors, and textures.

D. Verification Samples: Submit door surface samples for each finish specified, 10 inch (254 mm) by 10 inch (254 mm) in size, illustrating finishes, colors, and textures.

E. Maintenance Data: Include instructions for repair of minor scratches and damage.

F. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer; include detailed terms of warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than five years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Mark doors with location of installation, door type, color, and weight.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Store materials in original packaging, under cover, protected from exposure to harmful weather conditions and from direct contact with water.
   1. Store at temperature and humidity conditions recommended by manufacturer.
   2. Do not use non-vented plastic or canvas shelters.
   3. Immediately remove wet wrappers.

D. Store in position recommended by manufacturer, elevated minimum 4 inches (102 mm) above grade, with minimum 1/4 inches (6 mm) space between doors.

E. All damaged or otherwise unsuitable doors and frames, when so ascertained by the Owner, shall be replaced.

1.08 FIELD CONDITIONS

A. Obtain hardware manufacturer's templates prior to starting fabrication.

B. Do not install doors until structure is enclosed.

C. Maintain temperature and humidity at manufacturer's recommended levels during and after installation of doors.

1.09 WARRANTY

A. Provide ten (10) year manufacturer warranty covering materials and workmanship, including degradation or failure due to chemical contact.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Molded Fiberglass Doors:
   1. ChemPruf Door Company, Ltd: www.chem-pruf.com.
   2. Tiger Door LLC Izard Street, Omaha, NE 68102: www.tigerdoor.com.
   3. Substitutions: Not permitted.

2.02 DOOR AND FRAME ASSEMBLIES

A. Door and Frame Assemblies: Factory-fabricated, prepared and machined for hardware.
   1. Mechanical Durability: Tested to ANSI A250.4 Level A (1,000,000 cycles), minimum; tested with hardware and fasteners intended for use on project.
   2. Screw-Holding Capacity: Tested to 900 psi (6200 kPa), minimum.
   3. Surface Burning Characteristics: Flame spread index of 25 or less, smoke developed index of 450 or less; when tested in accordance with ASTM E 84.
   4. Flammability: Self-extinguishing when tested in accordance with ASTM D 635.
   5. Chemical Resistance: Resist degradation due to exposure to tap water, distilled water, and:
      a. Chlorine-treated moisture in air.
      b. Ocean salt spray.
   6. Sizes: As indicated on drawings.
   7. Clearance Between Door and Frame: 1/8 inch (3 mm), maximum.
   8. Clearance Between Meeting Stiles of Pairs of Doors: 1/8 inch (3 mm), maximum.

9. Clearance Between Bottom of Door and Finished Floor: 3/4 inch (19 mm), maximum; not less than 1/4 inch (6 mm) clearance to threshold.
10. Provide frame anchors that allow for variation in rough opening size; do not field cut doors or frames to fit.

2.03 COMPONENTS

A. Doors: Through-color gel coating on fiberglass reinforced polyester resin construction with reinforced core;.
   1. Thickness: 1-3/4 inches (44 mm), overall.
   2. Door Construction: Fiberglass faces laminated to core with subsequently applied gel coating, or molded in one piece including gel coating on all sides.
   3. Subframe and Reinforcements: Provide a pultruded FRP Channel within the door. All connections shall be chemically welded No mechanical fasteners will be allowed. The use of aluminum,steel, gypsum or wood is not permited.
   4. Internal Construction:
      a. Core: Phenolic impregnated Honeycomb Core
      b. Stiles and Rails: Stiles and rails shall be 1-1/2" square pultruded fiberglass tubes. A polyester-based resin filled with 1/4" chopped glass strands and aerosol shall be used for reinforcements and corner blocks, etc. The bottom rail shall allow 1-1/4" inches of height alterability without loss of the panel's integrity.
   5. Hardware Preparations: Factory reinforce, machine, and prepare for all hardware including field installed items; provide high density polymer compression blocks, or solid compression blocking for each hardware item; make field cutting, drilling or tapping unnecessary; obtain manufacturer's templates for hardware preparations.
   6. Gel Coating: Ultraviolet stabilized polyester, industrial urethane chemical coating color topcoat. Door face color shall be indicated in the drawings. Gelcoat may not be sprayed onto the door face as a secondary coating.
   7. Gel Coating Thickness: Minimum 15 mils (0.38 mm) wet, plus/minus 3 mils (0.07 mm).
   8. Gel Coating Color: As selected from manufacturer's standard colors.

B. Frames: Profiles and dimensions as indicated on drawings; same type and construction used in mechanical durability test for doors.
   1. Construction for Non-Fire-Rated Doors:
      a. Fiberglass pultrusions with gel-coating matching doors. The frame section shall be standard double rabbeted 5 3/4" deep x 2" face 3/16" thick with integral 5/8" door stop with 1 15/16" soffits, to match hollow metal door frame configurations. Finish: factory applied two part aliphatic industrial polyurethane topcoat to match the color indicated in the drawings. Gelcoat may not be sprayed onto the frame as a secondary coating.
   2. Corner Joints: Knock down jambs and header shall be joined at corners via miter connections. Exposed fasteners for miter connections will not be acceptable except for wrap wall applications. One piece frames shall be factory joined via mitered connections then chemically welded with FRP material and ground smooth at frame face. Mechanical joints will not be accepted in lieu of welded frames if specified.
   3. At hardware cut-outs provide continuous backing or mortar guards of same material as frame, Chemically welded, water tight. Hardware reinforcement shall be FRP reinforcing Chemically welded to frame at required locations. Minimum pullout strength of 1100 lbs per #12 x 1" sheet metal screw is required. Mechanically fastened reinforcements are not permitted.
   4. Frame Anchors: Stainless steel, Type 304; provide 3 anchors in each jamb for heights up to 84 inches (2130 mm) with one additional anchor for each additional 24 inches (610 mm) in height. Provide single bolt anchor at center of all headers over four feet in nominal width. Stainless Steel bolts shall be furnished by the manufacturer.

C. Hinge and Hardware Fasteners: Stainless steel, Type 304 CRSS (18-8 series corrosion resistant stainless steel).A minimum of 900 lbs. pullout strength is required for each factory supplied hinge screw.

D. Reinforcements and Braces/Supports:
   1. Corner Reinforcement: 4" x 4" x 5-3/8" x 1/4" thick pultruded fiberglass angle. Attached to head bar at factory using stainless steel screws or suitable polymer rivets.
   2. Mortise Hinge Reinforcement: 1-1/2" x 7" x 1/4" thick polymer attached to frame by means of bonding and stainless steel countersunk screws.
   3. Closer Reinforcement: Same as mortise hinge reinforcement, less screws.
   4. Strike Reinforcement: 1-1/2" x 9" x 3/4" thick polymer material. Attached to frame by means of bonding and stainless steel countersunk screws or suitable polymer rivets.

E. Anchoring Systems: "T"-Strap or Stainless Steel Wire Anchor for masonry construction

2.04 ACCESSORIES

A. Astragals for Inactive Leaves: Pultruded fiberglass angle or tee; same color as gel coat.

B. Louver Stops: Pultruded fiberglass unless otherwise indicated or required by fire rating; provided by door manufacturer to fit factory made openings, color and texture to match door; fasteners not penetrating waterproof integrity.
   1. Opening Sizes: As indicated on drawings.

C. Louvers for Non-Fire-Rated Doors: Same materials, construction, finish, and color as door; fixed vanes, 45 degree sloped vanes.

D. Hardware: As specified in Section 087100.

E. Thresholds: Pultruded fiberglass, with skid resistant surface, full width of door opening, 1/2 inch (13 mm) high by 6 inches (150 mm) wide; same color as frame.

2.05 FABRICATION

A. Fabricate FRP doors and frames as shown on the drawings and in accordance with best shop practices. Frames shall be rigid, neat in appearance and free from defects. Field measurements shall be taken as required for coordination with adjoining work.

B. Form exposed surfaces free from warp, wave and buckle, with all corners square, unless otherwise shown. Set each member in proper alignment and relationship to other members with all surfaces straight and in a true plane.

C. Reinforce members and joints with plates, tubes or angles for rigidity and strength. Doors and frames shall be mortised and reinforced for hardware in accordance with the hardware manufacturer's instructions and templates. The reinforcing shall be designed to receive hinges, locks, strikes, closures, etc.

D. Terminate bottom of frames at the indicated finished floor level. Provide clearance for doors of 1/8" at jambs and heads; 1/4" clearance above threshold.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify actual dimensions of openings by field measurements before door fabrication; show recorded measurements on shop drawings.

B. Do not begin installation until substrates have been properly prepared.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

B. Clean and prepare substrate in accordance with manufacturer's directions.

C. Protect adjacent work and finish surfaces from damage during installation.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions; do not penetrate frames with anchors.

B. Set units plumb, level, and true-to-line, without warping or racking doors, and with specified clearances; anchor in place.

C. In masonry walls, install frames prior to laying masonry; anchor frames into masonry mortar joints; fill jambs with grout as walls are laid up.

D. In stud walls, install frames prior to building walls; anchor frames to studs using concealed anchors.

E. Separate aluminum and other metal surfaces from sources of corrosion of electrolytic action at points of contact with other materials.

F. Repair or replace damaged installed products.

3.04 TOLERANCES

A. Maximum Diagonal Distortion: 1/8" measured with a straight edge, corner to corner. Maximum measurable plane is 4'-0" x 7'-0".

3.05 ADJUSTING

A. Lubricate, test, and adjust doors to operate easily, free from warp, twist or distortion, and to fit watertight for entire perimeter.

B. Adjust hardware for smooth and quiet operation.

C. Adjust doors to fit snugly and close without sticking or binding.

3.06 CLEANING

A. Clean installed products in accordance with manufacturer’s instructions prior to owner’s acceptance.

3.07 PROTECTION

A. Remove temporary coverings and protection of adjacent work areas.

B. Clean installed products in accordance with manufacturer’s instructions prior to owner’s acceptance. Repair or replace damaged installed products.

C. Protect adjacent work areas and finish surfaces from damage during installation.

D. Protect installed products from damage during subsequent work.

END OF SECTION

SECTION 083100

ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Access door and frame units in wall, and ceiling locations.

B. Provide as indicated, or not where indicated, where necessary to provide maintenance access to utilities and equipment.

1.02 RELATED SECTIONS

A. Section 042000 - Unit Masonry Assemblies: Openings in Masonry.

B. Section 092116 - Gypsum Board Assemblies: Openings in partitions and ceilings.

C. Section 099000 - Painting and Coating: Field paint finish.

D. Division 23: Mechanical components requiring access.

E. Division 26: Electrical components requiring access.

1.03 SUBMITTALS

A. Product Data: Provide sizes, types, finishes, hardware, anchorage accessories, scheduled locations, and details of adjoining work.

B. Shop Drawings: Indicate exact position of all access door units.

C. Manufacturer's Installation Instructions: Indicate installation requirements.

D. Project Record Documents: Record actual locations of all access units.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery of access doors with other work to avoid delays.

1.05 SEQUENCING AND SCHEDULING

A. Coordination: Supply access door anchors to be sequenced with other work to the respective trade for installation.
   1. Coordinate with other trades to determine quantity and locations of access doors required

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Access Doors:
   1. Bar-Co Division /ALFAB, Inc.
   2. J.L. Industries.
   3. Karp Associates, Inc; Product DSC-214M: www.karpinc.com.
   4. Milcor Inc; Product M or DW Standard Flush Access Door: www.milcorinc.com.
   5. Williams Brothers Corporation; Product WB-GP General Purpose Access Door: www.wbdoors.com.
   6. Substitutions: See Section 016000 - Product Requirements.

2.02 ACCESS DOORS AND PANELS

A. All Units: Factory fabricated, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies units are to be installed in.

2.03 WALL AND CEILING UNITS

A. Door and Frame Units: Formed steel.
   1. Frames: 18-gage.
   2. Door Panels: 14-gage.
   3. Size: As indicated on drawings.
   4. Hardware:
      a. Hinge: 175-degree stainless steel piano hinge with removable pin.
      b. Lock: Screwdriver slot for quarter turn cam lock.
   5. Finish: One coat baked enamel, grey color able to receive field applied paint finish.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Install frames plumb and level in openings. Secure rigidly in place.

C. Position units to provide convenient access to the concealed work requiring access.

3.03 ADJUSTING

A. Upon completion of installation, adjust door panels, hinges, and hardware to operate smoothly.

B. Remove and replace damaged or warped doors or frames.

END OF SECTION

SECTION 083300

COILING DOORS & GRILLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Overhead coiling doors, operating hardware, manual, and electric operation.

B. Wiring from electric circuit disconnect to operator to control station.

1.02 RELATED SECTIONS

A. Section 062000 – Finish Carpentry, related to closure “flip panel”

B. Section 087100 - Door Hardware: Cylinder cores and keys.

C. Section 099000 - Painting and Coating: Field paint finish.

D. Division 26 - Electrical: Power to disconnect.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel.

C. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

D. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

E. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

G. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association.

H. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association.

I. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.

J. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.

K. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.

1.04 SUBMITTALS

A. Product Data: Provide general construction, component connections and details, electrical equipment, if applicable, and finish data. Include both published data and specific data prepared for this project.

B. Shop Drawings: Indicate pertinent dimensioning on plans, sections and elevations, anchorage methods, hardware locations, and installation details.
   1. Show required clearances and relationship to adjacent materials.

C. Manufacturer's Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.

D. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

1.05 QUALITY ASSURANCE

A. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

B. Manufacturer: Coiling doors shall be manufactured by a firm with a minimum of five years experience in the fabrication and installation of rolling doors. Manufacturers proposed for use, which are not named in these specifications, shall submit evidence of ability to meet performance and fabrication requirements specified, and include a list of five projects of similar design and complexity completed within the past five years.

C. Installer: Installation of coiling doors shall be performed by an authorized representative of the manufacturer.

D. Single-Source Responsibility: Provide doors, guides, motors, and related primary components from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

E. Pre-Installation Conference: Schedule and convene a pre-installation conference just prior to commencement of field operations, to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS FOR OVERHEAD COILING DOORS

A. Overhead Door Corporation; 800-929-2553 or 717-248-0131; www.overheaddoor.com.

2.02 OVERHEAD COILING DOORS

A. Trade Reference: 610 Series Service Door by Overhead Door Corporation.

B. Design Wind Load: Capable of withstanding positive and negative wind loads of 24 psf without undue deflection or damage to components.

C. Mounting: Face-of-wall mounting, unless noted otherwise.

D. Finish: Galvanized steel unless noted otherwise.
   1. Slats, hood and supports shall be galvanized in accordance with ASTM A 653 and receive rust-inhibitive baked-on prime paint. Primer to be compatible with field applied finish.
   2. Non-galvanized exposed ferrous surfaces shall receive one coat of rust-inhibitive primer.

2.03 MATERIALS

A. Curtain Construction: Interlocking roll formed slats.
   1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
   2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
   3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.

B. Guide Construction: Continuous galvanized steel angle, of profile to retain door in place with snap-on trim, mounting brackets of same metal.

C. Brackets: Support for counterbalance, curtain and hood.

D. Hood Enclosure: Galvanized steel, internally reinforced to maintain rigidity and shape.
   1. Minimum 24 gage.
   2. Hood is not to contain any manufacturer applied graphics.

E. Manufacturer's Labels
   1. The finished, exposed faces of the unit shall not contain any labels, tags, advertisements, or other extraneous text or graphics.

F. Hardware:
   1. Latching: Inside mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position.

A

G. Installation options
   1. Provide governor installed to the coiling door operator. Governor shall be designed to engage and lock the coiling mechanism in the event of failure of the operator or spring.

2.04 ELECTRIC OPERATION

A. Electric Operators:
   1. Mounting: Side mounted.
   2. Motor Enclosure:
      a. Exterior doors: NEMA MG 1 Type 4; open drip proof.
      b. Interior doors: NEMA MG 1 Type 1; open drip proof.
   3. Motor Rating: 1/3 hp (250 W); continuous duty.
   4. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
   5. Controller Enclosure: NEMA 250 Type 1.
   6. Opening Speed: 12 inches per second (300 mm/s).
   7. Brake: Adjustable friction clutch type, activated by motor controller.
   8. Manual override in case of power failure.

B. Control Station: Standard three button (OPEN-STOP-CLOSE) momentary control for each operator.
   1. 24-volt circuit.
   2. Surface mounted.

C. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. In addition, install fire-rated doors in accordance with NFPA 80.

C. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

D. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

E. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

F. Coordinate installation of electrical service with Division 26.

G. Complete wiring from disconnect to unit components.

H. Complete wiring from fire alarm system.

I. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 079200.

J. Install perimeter trim and closures.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation From Plumb: 1/16 inch (1.5 mm).

C. Maximum Variation From Level: 1/16 inch (1.5 mm).

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft (3 mm per 3 m) straight edge.

3.04 ADJUSTING

A. Test and adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. Clean installed components per manufacturer's recommendations.

B. Remove labels and visible markings, including all adhesive.

C. Touch up damaged coatings and finishes. Repair any minor damage.

END OF SECTION

SECTION 084313

ALUMINUM-FRAMED STOREFRONTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Aluminum-framed storefront, with vision glass.

B. Aluminum doors and frames.

C. Weatherstripping.

D. Door hardware.

E. Perimeter sealant.

1.02 RELATED SECTIONS

A. Section 051200 - Structural Steel: Steel attachment members.

B. Section 079200 - Joint Sealers: Perimeter sealant and back-up materials.

C. Section 087100 - Door Hardware: Hardware items other than specified in this section.

D. Section 088000 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association.

C. AAMA 501.2 - Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage; American Architectural Manufacturers Association.

D. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association.

E. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections; American Architectural Manufacturers Association.

F. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

G. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

H. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

I. ASTM E 283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

J. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.

K. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordinate with installation of other components that comprise the exterior enclosure.

B. Pre-installation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 PERFORMANCE REQUIREMENTS

A. Design and size components to withstand the following load requirements without damage or permanent set, when tested in accordance with ASTM E 330, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
   1. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.

B. Movement: Accommodate movement between storefront and perimeter framing and deflection of lintel, without damage to components or deterioration of seals.

C. Air Infiltration: Limit air infiltration through assembly to 0.06 cu ft/min/sq ft (0.3 L/s/sq m) of wall area, measured at a reference differential pressure across assembly of 1.57 psf (75 Pa) as measured in accordance with ASTM E 283.

D. Water Leakage: None, when measured in accordance with ASTM E 331 with a test pressure difference of 2.86 lbf/sq ft (140 Pa).

E. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.

F. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F (95 degrees C) over a 12-hour period without causing detrimental effect to system components, anchorages, and other building elements.

1.06 SUBMITTALS

A. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, internal drainage details.

B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

C. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.

D. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

E. Sample: Submit three samples 4 inches square in size illustrating finish.

F. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.07 QUALITY ASSURANCE

A. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in project's jurisdiction.

B. Manufacturer and Installer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum three years of documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.09 FIELD CONDITIONS

A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C). Maintain this minimum temperature during and 48 hours after installation.

1.10 WARRANTY

A. Correct defective Work within a five-year period after Date of Substantial Completion.

B. Provide five-year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

C. Provide five-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Kawneer Company, Inc; Product Series: Trifab VG 451T Framing System: www.kawneer.com. Framing Member Profile 2"x 4 1/2"; Front, Center, Back, Multi-Pane Structural Silicone or Weatherseal (type B) Glazed.
   2. United States Aluminum Corp: www.usalum.com.
   3. Vistawall Architectural Products: www.vistawall.com.
   4. Substitutions: See Section 016000 - Product Requirements.

2.02 COMPONENTS

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
   1. Finish: Class I natural anodized.
   2. Color: As selected from manufacturer's standards unless noted otherwise.

B. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
   1. Glazing stops: Flush.
   2. Cross-Section: As indicated on drawings.

C. Doors: Glazed aluminum.
   1. Thickness: 1-3/4 inches (43 mm).
   2. Top Rail: 5 1/2 inches (140 mm) wide.
   3. Vertical Stiles: 5 1/2 inches (140 mm).
   4. Bottom Rail: 10 inches (254 mm) wide.
   5. Glazing Stops: Square.
   6. Finish: Same as storefront.

2.03 MATERIALS

A. Extruded Aluminum: ASTM B 221 (ASTM B 221M).

B. Fasteners: Stainless steel.

C. Exposed Flashings: 0.032 inch (0.8 mm) thick aluminum sheet; finish to match framing members.

D. Perimeter Sealant: As specified in Section 079200.

E. Glass: As specified in Section 088000.

F. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.04 FINISHES

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.

B. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils (0.018 mm) thick.

2.05 HARDWARE

A. Door Hardware: Storefront manufacturer's standard type to suit application.
   1. Finish on Hand-Contacted Items: Polished stainless steel.
   2. Include for each door weatherstripping, sill sweep strip, threshold, pivots, narrow stile handle latch, and closer.

B. Weatherstripping: Wool pile, continuous and replaceable; provide on all doors.

C. Threshold: Extruded aluminum, one piece per door opening, ribbed surface; provide on all doors.

2.06 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

E. Arrange fasteners and attachments to conceal from view.

F. Reinforce components internally for door hardware.

G. Reinforce framing members for imposed loads.

H. Finishing: Apply factory finish to all surfaces that will be exposed in completed assemblies.
   1. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.

G. Coordinate attachment and seal of perimeter air and vapor barrier materials.

H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

I. Install hardware using templates provided.

J. Install glass and infill panels in accordance with Section 088000, using glazing method required to achieve performance criteria.

K. Install perimeter sealant in accordance with Section 079200.

L. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

A. Maximum Variation from Plumb: 0.06 inches every 3 ft (1.5 mm/m) non-cumulative or 1/16 inches per 10 ft (1.5 mm/3 m), whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch (0.8 mm).

3.04 ADJUSTING

A. Adjust operating hardware and sash for smooth operation.

3.05 CLEANING

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

C. Remove excess sealant by method acceptable to sealant manufacturer.

3.06 PROTECTION

A. Protect installed products from damage during subsequent construction.

END OF SECTION

SECTION 087100

DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes furnishing and installation of door hardware for doors specified in “Hardware Sets” and required by actual conditions. Including screws, bolts, expansion shields, electrified door hardware, and other devices for proper application of hardware.

B. Where items of hardware are not specified and are required for intended service, such omission, error or other discrepancy shall be submitted to Architect 14 calendar days prior to bid date for clarification by addendum.

1.02 RELATED SECTIONS:

A. Section 061000 Rough Carpentry
B. Section 079200 Joint Sealants
C. Section 081110 Metal Doors and Frames
D. Section 081613 Fiberglass Doors and Frames

1.03 REFERENCES

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI):
   1. ANSI/BHMA A156.1 Butts & Hinges
   2. ANSI/BHMA A156.3 Exit Devices
   3. ANSI/BHMA A156.4 Door Controls – Closers
   4. ANSI/BHMA A156.6 Architectural Door Trim
   5. ANSI/BHMA A156.8 Door Controls – Overhead Stops and Holders
   6. ANSI/BHMA A156.13 Mortise Locks & Latches
   7. ANSI/BHMA A156.16 Auxiliary Hardware
   8. ANSI/BHMA A156.18 Materials & Finishes
   9. ANSI/BHMA A156.21 Thresholds
   10. ANSI/BHMA A156.22 Door Gasketing Systems
   11. ANSI/BHMA A156.26 Continuous Hinges
   12. ANSI/BHMA A156.28 Keying Systems

C. International Code Council/American National Standards Institute (ICC/ANSI):
   1. ICC/ANSI A117.1 Standards for Accessible and Usable Buildings and Facilities.

D. Underwriters Laboratories, Inc. (UL):
   1. UL 10C Positive Pressure Fire Test of Door Assemblies.
   2. UL 1784 Air Leakage Test of Door Assemblies.
   3. UL 294 Access Control System Units

E. Door and Hardware Institute (DHI):
   1. DHI Publication – Keying Systems and Nomenclature
   2. DHI Publication – Abbreviations and Symbols
   3. DHI Publication – Installation Guide for Doors and Hardware
   4. DHI Publication – Sequence and Format of Hardware Schedule

F. Building Codes
   1. Applicable building codes as listed in Section 010300.
   2. NFPA 70 National Electrical Code
   3. NFPA 80 – Standard for Fire Doors and Fire Windows; National Fire Protection Association.

4. NFPA 101 Life Safety Code
5. NFPA 252 – Standard Methods of Fire Tests of Door Assemblies; Nation Fire Protection Association.
6. UL (BMD) – Building Materials Directory; Underwriters Laboratories Inc.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Hardware schedule shall be organized in vertical format illustrated in DHI Publications Sequence and Formatting for the Hardware Schedule. Include abbreviations and symbols page according to DHI Publications Abbreviations and Symbols. Complete nomenclature of items required for each door opening as indicated.
   2. Coordinate final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of hardware.
   3. An Architectural Hardware Consultant (AHC), as certified by DHI, who shall affix seal attesting to completeness and correctness, shall review hardware schedule prior to submittal.

B. Submit manufacturer's catalog sheet on design, grade and function of items listed in hardware schedule. Identify specific hardware item per sheet, provide index, and cover sheet.

C. Coordination:
   1. Distribute door hardware templates to related divisions within 14 calendar days of approved hardware schedule.

D. After hardware submittal is approved, provide for each electrified opening, 3 copies of point to point diagrams.

E. Closeout Submittals: Submit to Owner in a three ring binder.
   1. Warranties.
   2. Maintenance and operating manual.
   3. Maintenance service agreement.
   4. Copy of approved hardware schedule.
   5. Copy of approved keying schedule with bitting list.
   6. Hardware supplier name, phone number and fax.

1.05 QUALITY ASSURANCE

A. Listed and Labeled electrified door hardware as defined in NFPA 70, Article 100, by a testing agency acceptable to authority having jurisdiction.

B. Hardware supplier shall employ an Architectural Hardware Consultant (AHC) as certified by DHI and a member of the seal program who shall be available at reasonable times during course of work for Project hardware consultation.

C. Door hardware shall conform to ICC/ANSI A117.1.

D. Fire Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and/or labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL 10C, unless otherwise indicated.

E. Door hardware shall be certified to ANSI/BHMA standards as noted, participate and be listed in BHMA Certified Products Directory.

F. Keying Meeting: Comply with requirements in Division 1 Section "Project Meetings."
   1. Within fourteen days of receipt of approved door hardware submittals, contact Owner with representative from hardware supplier to establish a keying conference. Verify keyway, visual key identification, number of master keys and keys per lock. Provide keying system per Owner's instructions.

G. Pre-installation Meeting: Comply with requirements in Division 1 Section “Project Meetings.”
   1. Convene meeting seven calendar days before installation. Participants required to attend meeting: Contractor, installer, material supplier, and manufacturer representatives.
   2. Include in conference decisions regarding proper installation methods and procedures for receiving and handling hardware.
   3. Review and finalize construction schedule and verify availability of materials, installer’s personnel, equipment and facilities needed to make progress and avoid delays.

H. Installer Qualifications: Specialized in performing installation of this Section and shall have 5 years minimum documented experience.

I. Hardware listed in 3.07- Hardware Schedule is intended to establish a type and grade.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide a clean, dry and secure room for hardware delivered to Project but not yet installed.

B. Furnish hardware with each unit marked and numbered in accordance with approved finish hardware schedule. Include door and item number for each type of hardware.

C. Pack each item complete with necessary parts and fasteners in manufacturer’s original packaging.

D. Deliver permanent key, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to Owner shall be established at “Keying Conference.”

E. Waste Management and Disposal
   1. Separate waste materials for reuse or recycling in accordance with Division 01- Section 017000 Construction Procedures, Waste Management and Disposal.

1.07 WARRANTY

A. General Warranty: Owner may have under provisions of the Contract Documents and shall be an addition and run concurrent with other warranties made by Contractor under requirements of the Contract documents.

B. Special Warranty: Warranties specified in this article shall not deprive Owner of other rights. Contractor, hardware supplier, and hardware installer shall be responsible for servicing hardware and keying related problems.
   1. Ten years for manual door closers.
   2. Five years for mortise, auxiliary and bored locks.
   3. Five years for exit devices.

C. Products judged defective during warranty period shall be replaced or repaired in accordance with manufacturer’s warranty at no cost to Owner. There is no warranty against defects due to improper installation, abuse and failure to exercise normal maintenance.

PART 2 - PRODUCTS

2.01 HINGES

A. Continuous Geared Hinges:
   1. Hinge weight and size requirements unless otherwise indicated in hardware sets:
      a. Choose proper weight of hinge according to manufacturer’s recommendations taking into consideration weight of door, weight of finish hardware applied to door, location and frequency of usage.
      b. Size of hinge to be 1” less door height.
   2. Base material: Anodized aluminum manufactured from 6063-T6 material, unexposed working metal surfaces shall be coated with TFE dry lubricant

a. Stainless steel shall be used at FRP doors.

3. Bearings:
   a. Vertical loads shall be carried on Lubriloy RL bearings for non Fire Rated doors.
   b. Standard weight hinges shall have a minimum spacing between bearings of 5-1/8". Typical door from 80" to 84" in height to have a minimum of 16 bearings.
   c. Heavy Weight hinges shall have a minimum spacing between bearings of 2-9/16". Typical door from 80" to 84" in height to have a minimum of 32 bearings.
4. Hinge Design and Options:
   a. Hinges shall have Rounded Back Cover Channel (RBCC).
5. Acceptable Manufactures: Heavy Weight
   a. Hager: 780-224HD
   b. Select: SL-24HD
   c. Pemko: FM HD

B. Butt Hinges:
1. Hinge weight and size unless otherwise indicated in hardware sets:
   a. Doors up to 36" wide and up to 1-3/4" thick provide hinges with a minimum thickness of .134" and a minimum of 4-1/2" in height.
   b. Doors from 36" wide up to 42" wide and up to 1-3/4" thick provide hinges with a minimum thickness of .145" and a minimum of 4-1/2" in height.
   c. For doors from 42" wide up to 48" wide and up to 1-3/4" thick provide hinges with a minimum thickness of .180" and a minimum of 5" in height.
   d. Doors greater than 1-3/4" thick provide hinges with a minimum thickness of .180" and a minimum of 5" in height.
   e. Width of hinge is to be minimum required to clear surrounding trim.
2. Base material unless otherwise indicated in hardware sets:
   a. Exterior Doors: 304 Stainless Steel, Brass or Bronze material.
   b. Interior Doors: Steel material.
   c. Fire Rated Doors: Steel or 304 Stainless Steel materials.
   d. Stainless Steel ball bearing hinges to have stainless steel ball bearings. Steel ball bearings are unacceptable.
   e. Stainless steel shall be used at FRP doors.
3. Quantity of hinges per door unless otherwise stated in hardware sets:
   a. Doors up to 60" in height provide 2 hinges.
   b. Doors 60" up to 90" in height provide 3 hinges.
   c. Doors 90" up to 120" in height provide 4 hinges.
   d. Doors over 120" in height add 1 additional hinge per each additional 30" in height.
   e. Dutch doors provide 4 hinges.
4. Hinge design and options unless otherwise indicated in hardware sets:
   a. Hinges are to be of a square corner five-knuckle design, flat button tips and have ball bearings unless otherwise indicated in hardware sets.
   b. Out-swinging exterior and out-swinging access controlled doors are required to have Non-Removable Pins (NRP) to prevent removal of pin while door is in closed position.
   c. When full width of opening is required, use hinges that are designed to swing door completely from opening when door is opened to 95 degrees.
   d. When shims are necessary to correct frame or door irregularities, provide metal shims only.
5. Acceptable Manufacturers: Standard Weight
   a. Hager: BB1279/BB1191
   b. Bommer: BB5000/BB502
   c. McKinney: TA2714/TA2314

2.02 LOCKS AND LATCHES

A. Locks and latches shall be of one manufacturer as listed for continuity of design and consideration of warranty.

B. Standards: Product to be certified and listed by following:
   1. ANSI/BHMA A156.13 Series 1000 Certified to Grade 1 for Operational and Security.
   2. UL/cUL Labeled and listed for functions up to 3 hours for single doors up to 48” in width and up to 96” in height.
   3. UL10C/UBC 7-2 Positive Pressure Rated.
   4. ICC/ANSI A117.1.

C. Lock and latch function numbers and descriptions of manufactures series as listed in hardware sets.

D. Material and Design:
   1. Lock cases from fully wrapped, 12-gauge steel, Zinc dichromate for corrosion resistance.
   2. Non-handed, field reversible without opening lock case.
   3. Break away spindles to prevent unlocking during forced entry or vandalism.
   4. Levers are to be Zinc cast, Forged Brass or Stainless Steel and plated to match finish designation in hardware sets.
      a. Stainless Steel shall be used at FRP doors
   5. Sectional Roses are to be of solid Brass or Stainless Steel material and have a minimum diameter of 2-7/16”.
      a. Stainless Steel shall be used at FRP doors
   6. Escutcheons are to be of solid Brass or Stainless Steel material.
      a. Stainless Steel shall be used at FRP doors
   7. Armor fronts are to be self-adjusting to accommodate a square edge door or a standard 1/8” beveled edge door.
   8. Stainless steel shall be used at FRP doors.

E. Latch and Strike:
   1. Stainless Steel latch bolt with minimum of ¾” throw and deadlocking for keyed and exterior functions.
   2. Strike is to fit a standard ANSI A115 prep measuring 1-1/4” x 4-7/8” with proper lip length to protect surrounding trim.
   3. Deadbolts to be 1-3/4” total length with a minimum of a 1” throw and ¾” internal engagement when fully extended and made of Stainless Steel material.

F. Electrified Locks
   1. Fail-Safe (power lock): Outside trim is locked when power is applied and unlocked when power is removed. Lockset will unlock in the event of a power failure (EL).
   2. Fail-Secure (power unlock): Outside trim is locked when there is no power and unlocked when power is applied. Lockset will be locked in the event of a power failure (EU).

G. Acceptable Manufactures:
   1. Hager Companies: 3800 Series.
   2. Schlage: L Series.
   3. Sargent: 8200 Series

2.03 EXIT DEVICES

A. Shall be touch pad type, finish to match balance of door hardware. Exit Devices shall be of one manufacturer as listed for continuity of design and consideration of warranty.
   1. Standards: Manufacturer to be certified by the following:
   2. Exit Devices: ANSI/BHMA A156.3 Grade 1
   3. UL labeled panic exit hardware.
   4. UL labeled fire exit hardware.

B. Material and Design:
   1. Touch pad shall extend a minimum of one half-door width.
   2. Freewheeling lever design shall match design of locks levers.
   3. Exit device to mount flush with door.

4. Stainless steel shall be used at FRP doors.

C. Components:
   1. Covers and end caps shall be brass, bronze, or stainless steel.
   2. Chassis shall be aluminum.

D. Latchbolts:
   1. Rim Device – ¾" throw, Pullman type with automatic dead-latching, stainless steel.
   2. Surface vertical rod device – top ½" throw, Pullman type with automatic dead-latching, stainless steel. Bottom ½" throw, Pullman type, held retracted during door swing, stainless steel.

E. Lock and Latch Functions: Function numbers and descriptions of manufacturer's series and lever styles indicated in door hardware sets.

F. Fasteners:
   1. Wood and machine screws and thru-bolts.

G. Acceptable Manufactures:
   1. Hager Companies: 4500 Series
   2. Von Duprin: 99 Series
   3. Sargent: 80 Series

2.04 ELECTROMAGNETIC LOCK

A. Provide field selectable 12/24VDC, weather-resistant, and up to 1500 lbs of holdings force, no residual magnetism, built in "Remote Lock Status" switch, and surge protection.

B. Mounting:
   1. Single swing gate installation, through bolt mounting, ½" or ¾" conduit fittings.
   2. Provide mounting brackets for proper installation.

2.05 CYLINDERS AND KEYING

A. Cylinders shall be of one manufacturer as listed for continuity of design and consideration of warranty.
   1. Acceptable Manufacturer: Schlage Classic C Cores. No substitutions allowed.
   2. Keyway as directed by owner

B. Standards:
   1. DHI Handbook "Keying systems and nomenclature" (1989)
   2. Auxiliary Locks: ANSI/BHMA A156.5

C. Cylinders:
   1. Manufacturer's standard tumbler type.
   2. Shall be furnished with cams/tailpieces as required for locking device that is being furnished for project.

D. Keying:
   1. Contact Owner with representative from hardware supplier to establish a keying conference. Verify keyway, visual key identification, number of master keys and keys per lock. Provide keying system per Owners instructions.
   2. Copy of Owners approved keying schedule shall be submitted to Owner and Architect with documentation of which keying conference was held and Owners sign-off.
   3. Provide a bitting list to Owner of combinations as established, and expand to twenty five percent for future use or as directed by Owner.
   4. Key into Owner's existing keying system if applicable.
   5. Keys to be shipped to Owner's representative, individually tag per keying conference.
   6. Provide visual key control identification on keys.

2.06 CLOSERS

A. Shall be product of one manufacturer. Unless otherwise indicated on hardware schedule, comply with manufacturer's recommendation for size of closer, depending on width of door, frequency of use, atmospheric pressure, ADAAG requirements, and fire rating.

B. Standards: Manufacturer to be certified and or listed by the following:
   1. Closers ANSI/BHMA A156.4 Grade 1
   2. ICC/ANSI A117.1
   3. UL/cUL listed up to 3 hours.
   4. UL10C Positive Pressure Rated

C. Provide cast iron non-handed bodies with full plastic covers.
   1. Closers shall have separate staked adjustable valve screws for latch speed, sweep speed, and backcheck. Provide Tri-Pack arms and brackets for regular arm, top jamb, and parallel arm mounting for each closer.

D. Components:
   1. One-piece seamless steel spring tube to seal in hydraulic fluid.
   2. Double heat-treated steel tempered springs.
   3. Precision-machined heat-treated steel piston.
   4. Triple heat-treated steel spindle.
   5. Full rack and pinion operation.

E. Mounting:
   1. Out swing doors shall have surface parallel arm mount closers except where noted on hardware schedule.
   2. In swing doors shall have surface regular arm mount closers except where noted on hardware schedule.
   3. Provide brackets and shoe supports for aluminum doors and frames to mount fifth screw.
   4. Furnish drop plates where top rail conditions on door do not allow for mounting of closer and where backside of closer is exposed through glass.

F. Size closers in compliance with requirements for accessibility (ADDAG). Comply with following maximum opening force requirements.
   1. Interior hinged openings: 5.0 lbs.
   2. Exterior hinged openings: 8.5 lbs.
   3. Fire Rated Openings: Minimum opening force allowable by authority having jurisdiction.

G. Fasteners: Provide self reaming and self-tapping wood and machine screws and sex nuts and bolts for each closer.

H. Acceptable manufactures:
   1. Hager Companies: 5100 Series
   2. LCN: 4040XP Series
   3. Sargent: 281 Series

2.07 OVERHEAD STOPS

A. Overhead stops and holders: Provide overhead stop and holders for doors that open against equipment, casework sidelights and other objects that would make wall stops/holders and floor stops/holders inappropriate. Provide sex bolt attachments for mineral core wood doors applications.

B. Acceptable Manufacturers:
   1. Rixson: 1 Series/9 Series
   2. Glynn Johnson: 100 Series/90 Series
   3. Sargent: 690 Series/590 Series

C. Standards: Manufacturer to be certified by the following:
   1. Overhead Stops and Holders: ANSI/BHMA A156.8

2.08 FLUSH BOLTS

A. Labeled Openings: Provide automatic or constant latching flush bolts per hardware schedule for inactive leaf of pairs of doors. Provide dust proof strikes for bottom bolt.

B. Non-Labeled openings: Provide two flush bolts for inactive leaf of pairs of doors per hardware schedule. Top bolt shall not be more than 78" centerline from floor. Provide dust proof strike for bottom bolt.

C. Acceptable Manufacturers:
   1. Hager Companies
   2. Rockwood
   3. Trimco

2.09 PROTECTIVE TRIM

A. Trim shall be of one manufacturer as listed for continuity of design and consideration of warranty.

B. For single doors, size two inches less door width (LDW) on push side of door, and one inch less on pull side of door by 8" high. For pairs of doors, size one inch less door width (LDW) on push side of door, and ½ inch on pull side of door.
   1. Kick Plates 10" high or size to door bottom rail height
   2. Mop Plates 4" high
   3. Armor Plates 36" high

C. Standards: Manufacturer to be certified by the following:
   1. Architectural Door Trim: ANSI/BHMA A156.6
   2. UL

D. Material and Design:
   1. 0.050" gage stainless steel.
   2. Corners square, polishing lines or dominant direction of surface pattern so they run across door width of plate.
   3. Bevel top, bottom, and sides uniformly leaving no sharp edges.
   4. Countersink holes for screws. Space screw holes so they are no more than eight inches CTC, along a centerline not over 1/2" in from edge around plate. End screws maximum of 0.53" from corners
   5. Stainless steel shall be used at FRP doors.

E. Fasteners: Supply #6 x 5/8" oval head screws, unless otherwise noted.

F. Acceptable Manufacturers:
   1. Hager Companies: 194S
   2. Rockwood: K1050 x B4E
   3. Trimco PG8002
   4. Burns

2.10 MODULAR ACCESS CONTROL POWER SUPPLIES

A. Power supplies of one manufacturer as listed for continuity of design and consideration of warranty.

B. Products to be certified and listed by the following:
   1. UL Listed.

C. Design:
   1. Use with modular access control systems.
   2. Field selectable filtered and regulated 12 VDC or 24 VDC constant voltage.

3. 1, 2, 4, and 6 AMP load capacities. Match the power supply amperage to the total load of the opening /system plus an additional thirty percent to cover line drop, as well as possible expansion.
4. Circuit breaker protected AC input voltage, secondary output PTC protected.
5. Fire alarm input provides simultaneous release of fail-safe locks and holders.
6. Interface relay.
7. LED status indicators provide information regarding AC input, DC output, and battery backup status.
8. Separate inputs for activation switch on entry and egress and ingress side of opening.
9. 5-amp hour battery backup.
10. Input 115 VAC (230 VAC optional).
11. Optional dual 12 VDC or 24 VDC output.
12. Optional power supply monitor module to monitor power supply status, A/C power, and D/C output and battery Status

D. Include optional modules as required to properly interface, control, and sequence the hardware with the access control system.

E. Acceptable Manufacturer:
1. Hager: 2908

2.11 DOOR GASKETING AND WEATHERSTRIP

A. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing where indicated on hardware schedule. Provide non-corrosive fasteners for exterior applications.
1. Perimeter gasketing: Apply to head and jamb, forming seal between door and frame.
2. Meeting stile gasketing: Fasten to meeting stiles, forming seal when doors are in closed position.
3. Door bottoms: Apply to bottom of door, forming seal with threshold or floor when door is in closed position.
4. Sound Gasketing: Cutting or notching for stop mounted hardware not permitted.

B. Standards: Manufacturer to be certified by the following:
1. Door Gasketing and Edge Seal Systems: ANSI/BHMA A156.22

C. Smoke-Labeled Gasketing: Comply with NFPA 105 listed, labeled, and acceptable to authorities having jurisdiction, for smoke control indicated.
1. Provide smoke labeled gasketing on 20-minute rated doors and on smoke rated doors.

D. Fire-Rated Gasketing: Comply with NFPA 80 listed, labeled, and acceptable to Authorities Having Jurisdiction, for fire ratings indicated.

E. Acceptable Manufacturers:
1. Perimeter Gasketing:
a. Hager Companies
b. National Guard
c. Pemko

2.12 THRESHOLDS

A. Thresholds of one manufacturer as listed for continuity of design and consideration of warranty.

B. Secured with lead expansion shields and stainless steel machine screws. Notched in field to fit frame by hardware installer. Refer to Drawings for special details.
1. Exterior and acoustical openigns to be set in full bed of sealant

C. Standards: Manufacturer to be certified by the following:
1. Thresholds: ANSI/BHMA A156.21

2. Americans with Disabilities Act Accessibility Guidelines (ADAAG).

D. Acceptable Manufacturers:
   1. Hager Companies: 520S/417S
   2. National Guard
   3. Pemko

2.13 DOOR GASKETING AND WEATHERSTRIP

A. Door gasketing and weatherstrip of one manufacturer as listed for continuity of design and consideration of warranty.

B. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing where indicated on hardware schedule. Provide noncorrosive fasteners for exterior applications.
   1. Perimeter gasketing: Apply to head and jamb, forming seal between door and frame.
   2. Meeting stile gasketing: Fasten to meeting stiles, forming seal when doors are in closed position.
   3. Door bottoms: Apply to bottom of door, forming seal with threshold or floor when door is in closed position.
   4. Sound Gasketing: Cutting or notching for stop mounted hardware not permitted.
   5. Drip Guard: Apply to exterior face of frame header. Lip length to extend 4” beyond width of door.

C. Products to be certified and listed by the following:
   1. Door Gasketing and Edge Seal Systems: ANSI/BHMA A156.22.
   2. BHMA certified for door sweeps, automatic door bottoms, and adhesive applied gasketing.

D. Smoke-Labeled Gasketing: Comply with NFPA 105 listed, labeled, and acceptable to Authorities Having Jurisdiction, for smoke control indicated.
   1. Provide smoke-labeled gasketing on 20-minute rated doors and on smoke rated doors.

E. Fire-Rated Gasketing: Comply with NFPA 80 listed, labeled, and acceptable to Authorities Having Jurisdiction, for fire ratings indicated.

F. Refer to Section 08 1416 Wood Doors for Category A or Category B. Comply with UBC 7-2 and UL10C positive pressure where frame applied intumescent seals are required.

G. Acceptable Manufacturers:
   1. Weatherstrip
      a. Hager: 881S/726
      b. K.N. Crowder
      c. Reese
   2. Door Bottom Sweeps
      a. Hager: 750S/770S
      b. K.N. Crowder
      c. Reese
   3. Meeting Stile Astragal
      a. Hager: 802S
      b. K.N. Crowder
      c. Reese
   4. Overlapping Astragal
      a. Hager: 835S
      b. K.N. Crowder
      c. Reese
   5. Overhead Drip Guard
      a. Hager: 810S
      b. K.N. Crowder

c. Reese

2.14 FINISHES

A. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if within 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 range of approved Samples.

B. Comply with base material and finish requirements indicated by BHMA designations in hardware schedule.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install hardware per manufacturer's instructions and in compliance with:
1. NFPA 80.
2. NFPA 105.
3. ICC/ANSI A117.1.
4. ANSI/BHMA A115.
5. UL10C/UBC7-2
6. Local building code.
7. Approved shop drawings.
8. Approved finish hardware schedule.

B. Install soffit mounted gaskets prior other soffit mounted hardware to provide a continuous seal around the perimeter of the opening without cutting or notching.

C. Install door closers so they are on the interior of the room side of the door. Stairwell doors will have closers mounted on the stair side and exterior doors will be mounted on the interior side of the building.

D. In drywall applications provide blocking material of sufficient type and size for hardware items that mount directly to the wall.

E. Locate wall mounted bumper to contact the trim of the operating trim.

F. Mount mop and kick plates flush with the bottom of the door and centered horizontally on the door.

G. Set thresholds for exterior, and acoustical doors at sound control openings in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants" forming a tight seal between threshold and surface to which set.

H. Anchor all components firmly into position and use anchoring devices furnished with the hardware item, unless otherwise specified.

I. Do not install surface mounted items until finishes have been completed on substrates involved. Set unit level, plumb and true to line location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.

3.03 FIELD QUALITY CONTROL

A. Material supplier to schedule final walk through to inspect hardware installation ten business days before final acceptance of Owner. Material supplier shall provide a written report detailing discrepancies of each opening to General Contractor within 7 calendar days of walk through.

3.04 ADJUSTMENT, CLEANING AND DEMONSTRATING

A. Adjustment: Adjust and check each opening to ensure proper operation of each item of finish ardware. Replace items that cannot be adjusted to operate freely and smoothly or as intended for application at no cost to Owner.

B. Cleaning: Clean adjacent surfaces soiled by hardware installation. Clean finished hardware per manufacturer's instructions after final adjustments has been made. Replace items that cannot be cleaned to manufacturer's level of finish quality at no cost to Owner.

C. Demonstration: Conduct a training class for building maintenance personnel demonstrating the adjustment, operation of mechanical and electrical hardware. Special tools for finished hardware to be turned over and explained usage at this meeting.

3.05 PROTECTION

A. Leave manufacturer's protective film intact and provide proper protection for all other finish hardware items that do not have protective material from the manufacture until Owner accepts Project as complete.

3.06 HARDWARE SETS

A. The following schedule of hardware sets shall be considered a guide only. Furnish door hardware to meet required codes.

3.07 HARDWARE SCHEDULE

A. Intent of Hardware Groups
   1. Should items of hardware not specified be required for completion of the Work, furnish such items of type and quality comparable to adjacent hardware and appropriate for service required.
   2. Where items of hardware aren't correctly specified and are required for completion of the Work, a written statement of such omission, error, or other discrepancy is required to be submitted to Architect, prior to date specified for receipt of bids for clarification by addendum; or, furnish such items in the type and quality established by this specification, and appropriate to the service intended.

B. Guide: Door hardware items have been placed in sets which are intended to be a guide of design, grade, quality, function, operation, performance, exposure, and like characteristics of door hardware, and may not be complete. Provide door hardware required to make each set complete and operational.

C. Hardware schedule does not reflect handing, backset, method of fastening, and like characteristics of door hardware and door operation.

D. Review door hardware sets with door types, frames, sizes and details on drawings. Verify suitability and adaptability of items specified in relation to details and surrounding conditions.

SET #1
Doors: 133A

5	Hinge(s)	BB1279 4 1/2 x 4 1/2 NRP	US26D	HA
1	Hinge	BB1279 4 1/2 X 4 1/2 ETW-4	US26D	HA
2	Exit Device	4501 SVR	US26D	HA
1	Exit Device Trim	45ET WTN EU	US26D	HA
1	Mortise Cylinder	3902 x LAR	US26D	HA
2	Panic Guard	PG8002 34"	630	TR
2	Closer	5100 HDCS	ALM	HA
1	Seal	726 x LAR	S	HA
2	Brush Weatherstrip	802S B x LAR	MIL	HA
2	Door Sweep	750S N x LAR	CLR	HA
1	Threshold	417S x LAR	MIL	HA
1	Power Supply	2908		HA

Card Reader by Security Contractor

Description of operation:
Door is normally closed and secure,
Access by key leaves trim in locked position
Upon proper credential validation, entry is permitted
Free egress all times
Door remains closed and locked upon power failure

SET #2
Doors: 136A

6	Hinge(s)	BB1191 4 1/2 X 4 1/2 NRP	US32D	HA
1	Set Auto Flush Bolts	291D	US32D	HA
1	Dust Proof Strike	280X	US26D	HA
1	Exit Device	4501N	US26D	HA
1	Exit Device Trim	45MN WTN	US26D	HA
1	Mortise Cylinder	3902 x LAR	US26D	HA
1	Coordinator	297D x LAR	BLACK	HA
2	Mounting Bracket	297N/297M (as required)	BLACK	HA
2	Closer	5100 HDCS	ALM	HA
2	Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
1	Seal	726 x LAR	S	HA
1	Set Weatherstrip	881S N 1 x LAR	MIL	HA
1	Astragal	835S x LAR	USP	HA
1	Drip Cap	810S x LAR	MIL	HA
2	Door Bottom	770S V x LAR	MIL	HA
1	Threshold	520S V x LAR		

SET #3
Doors: 211AX

2	Continuous Hinge	780-226HD LAR RBCC	CLR	HA
2	Exit Device	4501 CVR	US26D	HA
1	Exit Device Trim	45CE WTN	US26D	HA
1	Mortise Cylinder	3902 x LAR	US26D	HA

2	Closer	5100 HDCS	ALM	HA
1	Threshold	520S V x LAR	MIL	HA

NOTE: Door bottom, weather-stripping by door supplier

SET #4
Doors: 215A

6	Hinge(s)	BB1279 4 1/2 x 4 1/2 NRP	US26D	HA
2	Exit Devices	4501 CVR F	US26D	HA
1	Exit Device Trim	45CE WTN	US26D	HA
1	Mortise Cylinder	3902 x LAR	US26D	HA
2	Closer	5100 HDCS	ALM	HA
1	Seal	726 x LAR	S	HA
2	Meeting Stile Astragal	802S B x LAR	MIL	HA
2	Door Sweep	750S N x LAR	CLR	HA
1	Threshold	417S x LAR	MIL	HA

SET #5
Doors: 401AX

5	Hinge(s)	BB1191 4 1/2 X 4 1/2 NRP	US32D	HA
1	Hinge	BB1191 4 1/2 X 4 1/2 ETW-4	US32D	HA
2	Exit Device	4501 SVR	US26D	HA
1	Exit Device Trim	45ET WTN EU	US26D	HA
1	Mortise Cylinder	3902 x LAR	US26D	HA
2	Panic Guard	PG8002 34"	630	TR
2	Closer	5100 HDCS	ALM	HA
2	Brush Weatherstrip	802S B x LAR	MIL	HA
1	Set Weatherstrip	881S N 1 x 60" 2 x 84"	MIL	HA
1	Drip Cap	810S x LAR	MIL	HA
2	Door Bottom	770S V x LAR	MIL	HA
1	Threshold	520S V x LAR	MIL	HA
1	Power Supply	2908	HA	

Card Reader by Security Contractor

Description of operation:
Door is normally closed and secure,
Access by key leaves trim in locked position
Upon proper credential validation, entry is permitted
Free egress all times
Door remains closed and locked upon power failure

SET #6
Doors: 402AX

5	Hinge(s)	BB1191 4 1/2 X 4 1/2 NRP	US32D	HA
1	Hinge	BB1191 4 1/2 X 4 1/2 ETW-4	US32D	HA
1	Set Auto Flush Bolts	291D	US32D	HA
1	Dust Proof Strike	280X	US26D	HA
1	Electrified Lockset	3880ELEU SECT WTN	US26D	HA
1	Coordinator	297D x LAR	BLACK	HA
2	Mounting Bracket	297N/297M (as required)	BLACK	HA
2	Closer	5100 HDCS	ALM	HA
2	Kick Plate(s)	190S 10" x 1" LDW	US32D	HA
1	Seal	726 x LAR	S	HA
1	Set Weatherstrip	881S N 1 x LAR	MIL	HA
1	Astragal	835S x LAR	USP	HA
1	Drip Cap	810S x LAR	MIL	HA
2	Door Bottom	770S V x LAR	MIL	HA
1	Threshold	520S V x LAR	MIL	HA
1	Power Supply	2908	HA	

Card Reader by Security Contractor

Description of operation:
Door is normally closed and secure,
Access by key leaves trim in locked position
Upon proper credential validation, entry is permitted
Free egress all times
Door remains closed and locked upon power failure

END OF SECTION

SECTION 088000

GLAZING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Glass.

B. Glazing compounds and accessories.

1.02 RELATED REQUIREMENTS

A. Section 072500 - Weather Barriers.

B. Section 079200 - Joint Sealants: Sealant and back-up material.

C. Section 081110 - Metal Doors and Frames: Glazed doors and borrowed lites.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

C. ASTM C 864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.

D. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants.

E. ASTM C 1036 - Standard Specification for Flat Glass.

F. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass.

G. ASTM C 1193 - Standard Guide for Use of Joint Sealants.

H. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

I. ASTM E 1300 - Standard Practice for Determining Load Resistance of Glass in Buildings.

J. ASTM E 2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation.

K. GANA (GM) - GANA Glazing Manual; Glass Association of North America.

L. GANA (SM) - FGMA Sealant Manual; Glass Association of North America.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 PERFORMANCE REQUIREMENTS

A. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:
   1. In conjunction with vapor retarder and joint sealer materials described in other sections.
   2. To maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.

B. Select type and thickness of exterior glass to withstand dead loads and wind loads acting normal to plane of glass at design pressures calculated in accordance with local governing code.
   1. Use the procedure specified in ASTM E 1300 to determine glass type and thickness.

2. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.
3. Thicknesses listed are minimum.

1.06 SUBMITTALS

A. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

B. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors.

C. Samples: Submit two samples 12 x 12 inch in size of glass units, showing coloration and design.

D. Certificates: Certify that products meet or exceed specified requirements.

1.07 QUALITY ASSURANCE

A. Perform Work in accordance with GANA Glazing Manual and FGMA Sealant Manual for glazing installation methods. Maintain one copy on site.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience.

C. Standard for Sealed Insulating Glass Units: ASTM E 774, with compliance certified by independent certification program.
1. Label each unit permanently on spacer or on one pane. (Do not use ceramic label.)
2. Certification agency:
   a. Insulating Glass Certification Council (IGCC).
   b. Associated Laboratories, Inc. (ALI).

1.08 FIELD CONDITIONS

A. Do not install glazing when ambient temperature is less than 50 degrees F (10 degrees C).

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.09 WARRANTY

A. Sealed Insulating Glass Units: Provide a five (5) year warranty to include coverage for seal failure, interpane dusting or misting, including replacement of failed units.

1.10 MAINTENANCE PRODUCTS

A. Provide two of each glass size and each glass type, of insulated glass units and single glass.

PART 2 - PRODUCTS

2.01 GLAZING TYPES

A. Manufacturers:
1. PPG Industries, Inc.
2. Viracon, Inc.
3. Guardian Industries
4. Arch Aluminum & Glass Co., Inc.
5. Libby Owens Ford.

B. Type IG-1 - Sealed Insulating Glass Units: Safety glazing:
1. Applications: Provide this type of glazing in the following locations:
   a. Glazed lites in exterior doors.
   b. Glazed sidelights and panels next to doors.
   c. Other locations required by applicable federal, state, and local codes and regulations.

2. Type: Same as other vision glazing except use fully tempered float glass for both outboard and inboard lites.
3. Tint: Clear.

2.02 EXTERIOR GLAZING ASSEMBLIES

A. Structural Design Criteria: Select type and thickness to withstand dead loads and wind loads acting normal to plane of glass at design pressures calculated in accordance with applicable code.
   1. Use the procedure specified in ASTM E 1300 to determine glass type and thickness.
   2. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.
   3. Thicknesses listed are minimum.

B. Air and Vapor Seals: Provide completed assemblies that maintain continuity of building enclosure vapor retarder and air barrier:
   1. In conjunction with vapor retarder and joint sealer materials described in other sections.
   2. To maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.

2.03 GLASS MATERIALS

A. Float Glass Manufacturers:
   1. AGC Flat Glass North America, Inc: www.afgglass.com.
   2. Guardian Industries Corp: www.sunguardglass.com.
   3. Pilkington North America Inc: www.pilkington.com.
   4. PPG Industries, Inc: www.ppg.com.
   5. Substitutions: Refer to Section 016000 - Product Requirements.

B. Float Glass: All glazing is to be float glass unless otherwise indicated.
   1. Annealed Type: ASTM C 1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select).
   2. Heat-Strengthened and Fully Tempered Types: ASTM C 1048.
   3. Tinted Types: Color and performance characteristics as indicated.
   4. Thicknesses: As indicated; for exterior glazing comply with specified requirements for wind load design regardless of specified thickness.

C. Glass-Ceramic Safety Glazing: UL- or WH-listed as fire-protection-rated glazing and complying with 16 CFR 1201 test requirements for Category II without the use of a surface-applied film.
   1. Products:
      a. O'Keeffe's Inc. SAFTI Division; SAFTIFIRST.
      b. SCHOTT North America Inc; Pyran Star L (laminated) Fire Rated Ceramic Glass.
      c. Vetrotech Saint-Gobain North America;
      d. Substitutions: Refer to Section 016000 - Product Requirements.

2.04 SEALED INSULATING GLASS UNITS

A. Manufacturers:
   1. Any fabricator certified by glass manufacturer for type of glass, coating, and treatment involved and capable of providing specified warranty, if any.

B. Sealed Insulating Glass Units: Types as indicated above.
   1. Durability: Certified by an independent testing agency to comply with ASTM E 2190.
   2. Edge Spacers: Aluminum, bent and soldered corners.
   3. Edge Seal: Glass to elastomer with supplementary silicone sealant.
   4. Purge interpane space with dry hermetic air.

2.05 GLAZING COMPOUNDS

A. Glazing Putty (Type A): Non-hardening, knife grade consistency; ASTM C 1193, grey color.

B. Silicone Sealant (Type B): Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining; ASTM C 920, Type S, Grade NS, Class 25, Uses M, A, and G; cured Shore A hardness of 15 to 25; color as selected.

2.06 GLAZING ACCESSORIES

A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness, ASTM C 864 Option I. Length of 0.1 inch for each square foot (25 mm for each square meter) of glazing or minimum 4 inch (100 mm) x width of glazing rabbet space minus 1/16 inch (1.5 mm) x height to suit glazing method and pane weight and area.

B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness, ASTM C 864 Option I. Minimum 3 inch (75 mm) long x one half the height of the glazing stop x thickness to suit application, self-adhesive on one face.

C. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C 864 Option I; black color.

D. Glazing Clips: Manufacturer's standard type.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerance.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION

A. Prime surfaces scheduled to receive sealant.

B. Install sealants in accordance with ASTM C 1193 and FGMA Sealant Manual.

C. Install sealant in accordance with manufacturer's instructions.

3.03 INSTALLATION - EXTERIOR/INTERIOR DRY METHOD (GASKET GLAZING)

A. Place setting blocks at 1/4 points with edge block no more than 6 inches (150 mm) from corners.

B. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.

C. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.04 INSTALLATION - INTERIOR WET METHOD (COMPOUND AND COMPOUND)

A. Install glazing resting on setting blocks. Install applied stop and center pane by use of spacer shims at 24-inch (600 mm) centers, kept 1/4 inch (6 mm) below sight line.

B. Locate and secure glazing pane using glazers' clips.

C. Fill gaps between glazing and stops with glazing compound until flush with sight line. Tool surface to straight line.

3.05 CLEANING

A. Remove glazing materials from finish surfaces.

B. Remove labels after Work is complete.

C. Clean glass and adjacent surfaces.

3.06 PROTECTION

A. After installation, mark pane with an 'X' by using removable plastic tape or paste.

END OF SECTION

SECTION 089100

LOUVERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Fixed Wall Louvers, frames, and accessories.

B. Door Louvers.

1.02 RELATED SECTIONS

A. Section 054000 - Cold Formed Metal Framing: Wall Framing.

B. Section 076200 - Sheet Metal Flashing and Trim: Perimeter flashings and trim.

C. Section 079200 - Joint Sealants.

D. Section 081110 - Metal Doors and Frames.

E. Section 081416 - Flush Wood Doors.

F. Section 081613 - FRP Doors and Frames.

G. Section 092116 - Gypsum Board Assemblies: Wall Substrate

H. Section 099000 - Paints and Coatings: Field painting.

I. Division 23 - Mechanical Equipment: Ductwork attachment to louvers, fire/smoke dampers, actuators for operable louvers.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association.

C. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.

D. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; Air Movement and Control Association International, Inc.

E. AMCA 511 - Certified Ratings Program for Air Control Devices; Air Movement and Control Association International, Inc.

F. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

G. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

H. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

I. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

J. SSPC Paint 12 - Cold Applied Asphalt Mastic, The Society for Protective Coating.

1.04 SUBMITTALS

A. Product Data: Provide data describing design characteristics, maximum recommended air velocity, design free area, materials and finishes.

B. Shop Drawings: Indicate louver layout plan and elevations, opening and clearance dimensions, tolerances; head, jamb and sill details; blade configuration, screens, blankout areas required, and frames.

C. Samples: Submit two or four samples 2 by 2 inches (50 by 50 mm) in size illustrating finish and color of exterior and interior surfaces.

D. Test Reports: Independent agency reports showing compliance with specified performance criteria.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Maintenance Data: Include lubrication schedules, adjustment requirements and company's local contact.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum Five years of documented experience.

1.06 PROJECT CONDITIONS

A. Coordinate work of this section with installation of metal siding, masonry flashings; or exterior wall construction.

B. Coordinate work of this section with installation of mechanical ductwork and electrical services to motorized devices.

C. Field Measurements: Where conditions permit, take field measurements and determine actual installed positions of louvers before beginning louver fabrication.

1.07 WARRANTY

A. Provide twenty-year manufacturer warranty against distortion, metal degradation, and failure of connections.
   1. Finish Warranty: Submit a written warranty signed by the manufacturer guaranteeing fluoropolymer finish for 10 years after substantial completion, without reducing or otherwise limiting any other rights to correction which the owner may have under the contract documents. Failure is defined to include cracking, peeling, blistering, chalking, and fading in excess of 3 NBS points.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Wall Louvers:
   1. Airolite Company, LLC: www.airolite.com.
   2. Ruskin Manufacturing.
   3. Construction Specialties, Inc: www.c-sgroup.com.
   4. Substitutions: See Section 016000 - Product Requirements.

2.02 LOUVERS

A. Louvers: Factory fabricated and assembled, complete with frame, mullions, and accessories; AMCA Certified under AMCA 511.
   1. Wind Load Resistance: Design to resist positive and negative wind load of 25 psf (1.2 kPa) without damage or permanent deformation.
   2. Intake Louvers: Design to allow maximum of 0.01 oz/sq ft (3.1 g/sq m) water penetration at calculated intake design velocity based on design air flow and actual free area, when tested in accordance with AMCA 500-L.
   3. Drainable Blades: Continuous rain stop at front or rear of blade aligned with vertical gutter recessed into both jambs of frame.

4. Screens: Provide insect screens at intake louvers and bird screens at exhaust louvers.

B. Stationary Louvers: Horizontal blade, extruded aluminum construction, with concealed intermediate mullions as required.
   1. Basis of Design: Model No. K609; Airolite Co.
   2. Free Area: as noted on drawings.
   3. Static Pressure Loss: as noted on drawings.
   4. Frame: Depth as indicated on drawings, channel profile; corner joints mitered and mechanically fastened, with continuous recessed caulking channel each side.
      a. Provide 4 inches if no depth is noted on drawings.
   5. Metal Thickness: Frame 0.081 inch (2.06 mm); blades 0.081 inch (2.06 mm).
   6. Metal Thickness: Frame 0.06 inch (1.52 mm); blades 0.06 inch (1.52 mm).
   7. Finish: Fluoropolymer coating, finished after fabrication.
   8. Color: As selected from manufacturer's standard colors unless noted otherwise.

C. Stationary Door Louver: Horizontal blade, extruded aluminum construction, horizontal rain resistant.
   1. Basis of Design: Model No: AC505; Airolite Co.
   2. Free Area: As noted on drawings.
   3. Depth: 1 ½" to match door thickness.
   4. Metal Thickness: Frame and blades 0.081 inches.
   5. Finish: Fluropolymer coating finished after fabrication.
   6. Color: As selected from manufacturer's standard colors unless noted otherwise.

2.03 MATERIALS

A. Extruded Aluminum: ASTM B 221 (ASTM B 221M),.

B. Stainless Steel: ASTM A 666 Type 316L, soft temper, smooth surface, No. 4 finish.

C. Bird Screen: Interwoven wire mesh of aluminum or stainless steel, 0.063 inch (1.6 mm) diameter wire, 1/2 inch (13 mm) open weave, diagonal design.

D. Insect Screen: 18 x 16 size stainless steel mesh.

E. Polyvinylidene Fluoride Coating: Minimum 70 percent Kynar 500/Hylar 500 resin, two coat finish, complying with AAMA 2604.

F. Primer: Zinc chromate.

2.04 ACCESSORIES

A. Blank-Off Panels: Same material as louver, Same color and finish as louver on exterior side; provide where duct connected to louver is smaller than louver frame, sealing off louver area outside duct.

B. Screens: Frame of same material as louver, with mitered and welded corners; installed on inside face of louver frame.
   1. Position screen on inner louver face; attach using machine screws located 3 inches from corner and 12 inches on center between corners.

C. Fasteners:
   1. For aluminum members: Aluminum, stainless steel.
   2. For stainless steel members: Stainless steel.
   3. Finish exposed-to-view fastener heads to match adjacent surface.

D. Flashings: Of same material as louver frame, formed to required shape, single length in one piece per location.

E. Head and Sill Flashings: See Section 076200.

F. Sealant: See section 079200.

G. Anchors and Inserts: Hot dip galvanized steel or nonferrous metal.

H. Bituminous Paint: SSPC Paint 12; cold applied asphalt mastic.

2.05 FABRICATION

A. Provide complete, shop fabricated units.

B. Fabricate frames to indicated profiles with features and clearances to suit installation conditions.
   1. Include integral sills of finish and construction to match louver.
   2. Provide clearance or recesses as required to accommodate sealant between louver and adjacent construction.

C. Provide uniform spacing between blades, including gap between blades and exposed face of head and sill members.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that prepared openings and flashings are ready to receive work and opening dimensions are as indicated on shop drawings.

B. Verify that substrates and openings to receive louvers are rigidly set, at proper lines and elevation, properly sized, and ready to receive louvers.

C. Do not proceed with installation until conditions detrimental to proper installation have been corrected.

D. Verify that field measurements are as indicated on shop drawings.

3.02 PREPARATION

A. Coat contact surfaces of dissimilar metals with one or more coats of bituminous paint.
   1. The following metals are not considered dissimilar: Aluminum, stainless steel, and zinc.

B. Apply one 15 mil dry film thickness coat of bituminous isolation coating to metal surfaces, other than galvanized steel, which will be in contact with cementitious materials.

3.03 INSTALLATION

A. Install louver assembly in accordance with manufacturer's instructions and shop drawings.

B. Install louvers level and plumb. Set units and flashings in proper location, plumb and true, free of warp or twist.

C. Install flashings and align louver assembly to ensure moisture shed from flashings and diversion of moisture to exterior.

D. Secure louver frames in openings with concealed fasteners.

E. Install perimeter sealant and backing rod in accordance with Section 079200.

F. Coordinate with installation of mechanical ductwork.

G. Coordinate with installation of louver actuators.

H. Fit joints tightly; where joint sealers are to be installed, make joints of sizes required.

I. Coordinate louver installation with adjacent elements of building envelope to ensure watertight construction.

3.04 ADJUSTING

A. Adjust operable louvers for freedom of movement of control mechanism. Lubricate operating joints.

3.05 CLEANING

A. Remove protective material from prefinished surfaces immediately after installation.

B. Wash exposed surfaces using mild detergent.

C. Remove excess sealant by moderate use of mineral spirits or other solvent recommended by sealant manufacturer.

END OF SECTION

SECTION 092116

GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Performance criteria for gypsum board assemblies.

B. Metal stud wall framing.

C. Metal furring channels.

D. Metal channel ceiling framing.

E. Fire rated area separation walls.

F. Gypsum sheathing.

G. Cementitious backing board.

H. Gypsum wallboard.
   1. Gypsum Wallboard for General Use
   2. Water-Resistant Gypsum Backing Board
   3. Gypsum Sheathing Board

I. Joint treatment and accessories.
   1. Level 5 finish for vinyl graphics applied directly to walls and graphic wall coverings.

J. Water-resistive barrier over exterior wall sheathing.

1.02 RELATED SECTIONS

A. Section 033000 - Cast-in-place concrete: Substrate for installation of assembly in this section.

B. Section 054000 - Cold Formed Metal Framing: Exterior load bearing metal stud framing.

C. Section 061000 - Rough Carpentry: Building framing, blocking and sheathing.

D. Section 072100 - Thermal Insulation

E. Section 079200 - Joint Sealants

F. Section 092400 - Portland Cement Plaster: Finish treatment.

G. Section 097212 – Wall Coverings, Graphic: Finish treatment.

H. Section 099000 - Painting and Coating: Finish treatment.

I. Section 101900 – Exhibits and Graphics: Finish treatment for vinyl graphics applied directly to walls and graphic wall coverings.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ANSI A108.11 - American National Standard for Interior Installation of Cementitious Backer Units.

C. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units.

D. ASTM C 475/C 475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.

E. ASTM C 514 - Standard Specification for Nails for the Application of Gypsum Board.

F. ASTM C 557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.

G. ASTM C 645 - Standard Specification for Nonstructural Steel Framing Members.

H. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

I. ASTM C 840 - Standard Specification for Application and Finishing of Gypsum Board.

J. ASTM C 1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.

K. ASTM C 1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.

L. ASTM C 1177/C 1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.

M. ASTM C 1178/C 1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel.

N. ASTM C 1280 - Standard Specification for Application of Gypsum Sheathing.

O. ASTM C 1288 - Standard Specification for Discrete Non-Asbestos Fiber-Cement Interior Substrate Sheets.

P. ASTM C 1396/C 1396M - Standard Specification for Gypsum Board.

Q. ASTM C 1658/C 1658M - Standard Specification for Glass Mat Gypsum Panels.

R. ASTM D 3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.

S. ASTM E 72 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.

T. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

U. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

V. ASTM E 413 - Classification for Rating Sound Insulation.

W. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association.

X. ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers; ICC Evaluation Service, Inc.

Y. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.

1.04 SUBMITTALS

A. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system. Submit manufacturer's product data for systems required, including installation instructions and data sufficient to show compliance with requirements.

B. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

C. Test Reports: For all stud framing products that do not comply with ASTM C 645 or C 754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

D. Samples: Submit 3 samples of gypsum board finished with proposed texture application, 12 by 12 inches (300 by 300 mm) in size, illustrating finish color and texture.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum 5 years of documented experience.

B. Copies of Documents at Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original and unopened packages, containers, or bundles, with brand names and manufacturer's labels intact and legible.

B. Store materials in dry location, fully protected from weather and direct exposure to sunlight.

C. Stack gypsum board products flat and level, properly supported to prevent sagging or damage to ends and edges.

D. Store corner bead and other metal and plastic accessories to prevent bending, sagging, distortion, or other mechanical damage.

1.07 PROJECT CONDITIONS

A. Temperature: Maintain temperature in areas of installation between 50 and 70 degrees F for at least 24 hours before installation begins and for not less than 48 hours after joint finishing has been completed.

B. Ventilation: Provide controlled ventilation during joint finishing operations, to eliminate excessive moisture. Avoid drafts during hot, dry weather to prevent excessively fast drying of joint compound.

PART 2 - PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C 840 and GA-216.
   1. Finish of gypsum board to level specified for noted finish.

2.02 METAL FRAMING MATERIALS

A. Manufacturers - Metal Framing, Connectors, and Accessories:
   1. Clark Western Building Systems: www.clarkwestern.com.
   2. Dietrich Metal Framing: www.dietrichindustries.com.
   3. Marino\Ware: www.marinoware.com.
   4. Phillips Manufacturing Company: www.phillipsmfg.com.
   5. USG Corporation.
   6. Dale/Incor.
   7. Unimast, Inc. (formerly a part of USG)
   8. Gold Bond Building Products, a National Gypsum Division.
   9. Substitutions: See Section 016000 - Product Requirements.

B. Non-Loadbearing Framing System Components: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf (240 Pa).
   1. Studs: "C" shaped with flat or formed webs with knurled faces.
      a. Nominal depths: As indicated on drawings.
      b. Finish: Galvanized finish complying with ASTM A 653 for G60 coating designation.
   2. Runners: U shaped, sized to match studs.
      a. Nominal depths: As indicated on drawings.
      b. Finish: Galvanized finish complying with ASTM A 653 for G60 coating designation.
   3. Ceiling Channels: C shaped.

a. ASTM C 754, cold rolled or hot rolled steel, with rust inhibitive finish.
4. Furring: Hat-shaped sections, minimum depth of 7/8 inch (22 mm), except as otherwise indicated.
5. Resilient Furring Channels: Single leg, except as noted otherwise.
6. Furring Fasteners/Connectors: Manufacturer's recommended system for specific application indicated, complying with ASTM C 754.

C. Shaft Wall Studs and Accessories: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with specified UL ratings.

D. Ceiling Hangers: Type and size as specified in ASTM C 754 for spacing required.
1. Hanger Wire: ASTM A 641, soft, Class 1 galvanized.
a. Ceiling hangers: Minimum 8 gage wire.
b. Furring channel ties: Minimum 18 gage wire.

E. Partition Head to Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as required.

2.03 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
1. CertainTeed Corporation: www.certainteed.com.
2. Georgia-Pacific Gypsum LLC: www.gp.com/gypsum.
3. National Gypsum Company: www.nationalgypsum.com.
4. USG Corporation: www.usg.com.
5. Centex American Gypsum Company.
6. Domtar Gypsum.
7. Substitutions: See Section 016000 - Product Requirements.

B. Wallboard: Paper-faced gypsum wallboard as defined in ASTM C 1396/C 1396M; sizes to minimize joints in place; ends square cut.
1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D 3273.
a. Mold-resistant board is required whenever board is being installed before the building is enclosed and conditioned.
3. Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
4. Glass-Mat-Faced Products:
a. Georgia-Pacific Gypsum LLC; DensArmor Plus.
b. National Gypsum Company, “Gold Bond” Brand, Extended Exposure Interior Extreme.

C. Gypsum Wallboard: ASTM C 1396/C 1396M. Sizes to minimize joints in place; ends square cut.
1. Regular Type:
a. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
b. Thickness: 5/8 inch (16 mm), except as otherwise indicated.
c. Edges: Tapered.
2. Fire Resistant Type: Complying with Type X requirements; UL or WH rated.
a. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X.
b. Other Applications: Use at all vertical surfaces and Ceilings, unless otherwise indicated.
c. Thickness: 5/8 inch (16 mm).
d. Edges: Tapered.

D. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.
1. Application: Exterior sheathing, and all rooms exposed to outdoor humidity, unless otherwise indicated.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D 3273.

3. Glass-Mat-Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C 1177/C 1177M.
4. Edges: Square, for vertical application.
5. Glass-Mat-Faced Products:
   a. Georgia-Pacific Gypsum LLC; DensGlass Gold Sheathing.
   b. National Gypsum Company, “Gold Bond” Brand, EXP - Extended Exposure.

2.04 FIBERGLASS REINFORCED BOARD MATERIALS

A. Cementitious Backer Board: ANSI A118.9, aggregated portland cement panels with glass fiber mesh embedded in front and back surfaces, 1/2 inch (13 mm) thick.

2.05 ACCESSORIES AND TRIM

A. General: Except as otherwise specifically indicated, provide trim and accessories by manufacturer of gypsum board materials, made of galvanized steel or zinc alloy and configured for concealment in joint compound.
   1. Include corner beads, edge trim, and other trim units necessary for project conditions. Provide accessories as required in order to achieve details indicated, whether or not specific accessories are shown on the drawings.

B. Exposed Trim: At locations indicated, provide manufacturer's standard metal trim units designed to be left exposed or semi-exposed.

C. Water-Resistive Barrier: No. 15 asphalt felt.

D. Joint Materials: ASTM C 475 and as recommended by gypsum board manufacturer for project conditions.
   1. Tape: 2 inch (50 mm) wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
   2. Ready-mixed vinyl-based joint compound.

E. Sealing: At water resistant gypsum backing board, provide Type I organic adhesive per ANSI A136.1.

F. Textured Finish Materials: Latex-based compound; plain.

G. Screws for Attachment to Steel Members Less Than 0.03 inch (0.7 mm) In Thickness, to Wood Members, and to Gypsum Board: ASTM C 1002; self-piercing tapping type; cadmium-plated for exterior locations.

H. Screws: ASTM C 1002; self-piercing tapping type; cadmium-plated for exterior locations.
   1. Lengths as recommended by gypsum board manufacturer for project conditions.

I. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

J. Adhesive for Attachment to Wood: ASTM C 557.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C 754 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members at 16 inches (400 mm) on center, unless otherwise indicated.
   1. Secure hangers to structure or to anchorage devices so that full strength of hanger can be achieved.

2. Install ceiling channels at spacing indicated or required, but not greater than permitted by ASTM C 754.
3. Level ceiling and Soffit system to a tolerance of 1/8 inch in 12 feet, or to a higher tolerance if required by specific project conditions.
4. Laterally brace entire suspension system.
5. Reinforce openings and interruptions in horizontal framing system with additional furring channels. Ensure that entire suspension system is laterally braced.

C. Studs: Space studs at 16 inches (400 mm) on center, unless otherwise indicated.
1. Extend partition framing to structure where indicated and to ceiling in other locations.
2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.
4. Blocking and bracing: Install blocking and bracing as recommended by manufacturer for adequate support of wall mounted items installed as work of other sections.

D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs. Comply with recommendations of USG Corporation's "Gypsum Construction Handbook".

E. Standard Wall Furring: Install at concrete and masonry walls scheduled to receive gypsum board, not more than 4 inches (100 mm) from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 16 inches (400 mm) on center.
1. Orientation: Vertical.
2. Spacing: As indicated.

F. Furring for Fire Ratings: Install as required for fire resistance ratings indicated.

G. Blocking: Install for support of:
1. Framed openings
2. Wall mounted cabinets.
3. Plumbing fixtures.
4. Wall mounted door hardware.
5. Wall supported shelving.

3.03 BOARD AND GLASS MAT FACED BOARD INSTALLATION

A. Comply with ASTM C 840, GA-216, and manufacturer's instructions, except where exceeded by other requirements. Install to minimize butt end joints, especially in highly visible locations.
1. Apply ceiling boards prior to installation of wallboards. Arrange to minimize butt end joints near center of ceiling area.
2. Install wallboards in a manner which will minimize butt end joints in center of wall area. Stagger vertical joints on opposite sides of walls.
3. Butt all joints loosely, with maximum of 1/16 inch between boards.
4. Place wrapped edges adjacent to one another; do not place cut edges or butt ends adjacent to wrapped edges.
5. Support all edges and ends of each board on framing or by solid substrate, except that long edges at right angles to framing members in non-fire rated construction may be left unsupported.

B. Isolation Joints: Where gypsum board construction intersects structural components, provide isolation by stopping board a minimum of 1/4 inch from structure, for finishing by means of exposed or semi-exposed trim.

C. Installation on Metal Framing and Furring:

1. Single layer application: Install gypsum board by means of screw attachment.
    a. On walls and partitions, plan installation so that leading edge or end of gypsum board is attached to open end of stud flange first.
    b. Coordinate erection of sound rated wall construction.

D. Exterior Sheathing: Comply with ASTM C 1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.

3.04 INSTALLATION OF TRIM AND ACCESSORIES

A. General: Comply with manufacturer's recommendations for installation of trim items. Except for items intended by manufacturer to be left exposed or semi-exposed, install trim units for concealment in joint finishing compound. Wherever possible, fasten metal trim items to substrate with same fasteners used to install gypsum board products.

B. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
1. Not more than 30 feet (10 meters) apart on walls and ceilings over 50 feet (16 meters) long.
2. At exterior soffits, not more than 30 feet (10 meters) apart in both directions.

C. Corner Beads: Install metal corner bead at all external corners unless details clearly indicate its omission at specific locations.

D. Edge Trim: Install at locations where gypsum board abuts dissimilar materials, wherever edge of gypsum board otherwise would be exposed, and as indicated.

3.05 FINISHING GYPSUM BOARD

A. Finish gypsum board in accordance with levels defined in ASTM C 840, as follows:
1. Level 5: Walls and ceilings to receive semi-gloss, gloss paint finish, graphics applied directly to walls, graphic wall coverings, and other areas specifically indicated.
2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
3. Level 3: Walls to receive textured wall finish.
4. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
5. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.

B. All exposed gypsum board applications.
1. Embed tape in joint compound at all joints and interior angles. Provide three separate coats of compound at all joints, angles, fastener heads, and accessories. Provide smooth surfaces free of tool marks and ridges.

C. Tape, fill, and sand exposed joints, edges, and corners in accordance with manufacturer's instructions to produce smooth surface ready to receive finishes.

D. Penetrations: Fill cutouts and openings around fixtures and penetrations with joint compound.

3.09 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) in any direction.

3.10 CLEANING

A. Promptly remove any residual gypsum drywall materials from adjacent or adjoining surfaces, leaving spaces ready for subsequent finishing operations and decorating.

END OF SECTION

SECTION 092400

PORTLAND CEMENT PLASTER

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Portland cement plaster for installation over metal lath, concrete, and solid surfaces.

B. Plastic accessories.

C. Stucco finishes.

D. Metal lath and accessories.

1.02 RELATED SECTIONS

A. Section 054000 - Cold Formed Metal Framing: Structural metal framing for plaster.

B. Section 061000 - Rough Carpentry: Wood stud framing for plaster.

C. Section 079200 - Joint Sealants.

D. Section 083100 - Access Doors and Panels: Access panels.

E. Section 092116 - Gypsum Board Assemblies: Metal stud framing and furring for plaster.

1.03 THEMING DESIGN INTENT

A. General: Portland cement plaster exposed to public view shall be themed to include rounded edges, worn surfaces, varying thicknesses and textures, embedded items, and disguising of metal trim per the Character Reference Guide.
   1. Walls are not intended to appear square and plumb, but are intended to replicate an aged, hand-made application per the Character Reference Guide. Each building and structure may have a different character and level of finish.

B. Themed Plaster: Apply paint as a wash over three-coat paint system provided by Section 099000 Paints and Coatings and/or Section 099416 Themed Paint.

C. Non-themed Plaster: Plaster surfaces not exposed to the public shall be conventional system with visible metal trim and control joints. Three-coat paint system provided by Section 099000 Paints and Coatings.

1.04 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM C 91 - Standard Specification for Masonry Cement.

C. ASTM C 150 - Standard Specification for Portland Cement.

D. ASTM C 206 - Standard Specification for Finishing Hydrated Lime.

E. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes.

F. ASTM C 926 - Standard Specification for Application of Portland Cement-Based Plaster.

G. ASTM C 932 - Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering.

H. ICC (IBC) - International Building Code.

I. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.

J. PCA EB049 - Portland Cement Plaster/Stucco Manual; Portland Cement Association.

K. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.

1.05 SUBMITTALS

A. Product Data: Provide data on plaster materials, characteristics and limitations of products specified.

B. Samples: Submit three samples, 12 x 12 inch (300 x 300 mm) in size illustrating finish color and texture.

C. Qualification Data: For firms and persons installing themed plaster as 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.

D. Mix Designs for each type of mix used.

E. Samples for initial selection in the form of manufacturer's color charts consisting of actual units or sections of units at least 12 inches (300 mm) square showing the full range of colors, textures, and patterns available for each type of finish indicated.
   1. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.
   2. Include similar Samples of material for joints and accessories involving color selection.

F. Samples for verification in units at least 12 inches (300 mm) square of each type of finish indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.

G. Material Certificates: Submit certificate signed by manufacturer for each kind of plaster aggregate certifying that materials comply with requirements.

H. Components and Cladding Certificate: The method of attachment shall be in compliance with the local building codes as required.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C 926.

B. Conform to applicable code for fire rated assemblies as indicated on drawings.

C. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.

D. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

E. Installer Qualifications: An experienced installer who has completed themed plaster work 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.

F. Fire-Test-Response Characteristics: Where fire-resistance-rated portland cement plaster assemblies are indicated, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

G. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.

1.07 MOCK-UP

A. Mock-ups: Prior to installing plaster work, construct panels for each type of finish and application required to verify selections made under Sample submittals and to demonstrate aesthetic effects

as well as qualities of materials and execution. Build mock-ups to comply with the following requirements, using materials indicated for final unit of Work.

1. Locate mock-ups on-site in the location and of the size indicated or, if not indicated, as directed by Owner. Assure that the natural daylight and sun exposure will approximate the final installation.
2. Erect mock-ups 48 by 48 inches (1200 by 1200 mm) by full thickness in presence of Architect using materials, including lath, support system, and control joints, indicated for final Work. Include trims and moldings in the mock-up.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Owner's and/or Architect's approval of mock-ups before start of plaster Work.
5. Retain and maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed Portland cement plaster Work.

B. Locate where directed by Owner's Project Manager.

1.08 FIELD CONDITIONS

A. Do not apply plaster when substrate or ambient air temperature is under 50 degrees F (10 degrees C) or over 80 degrees F (27 degrees C).

B. Maintain minimum ambient temperature of 50 degrees F (10 degrees C) during installation of plaster and until cured.

C. Comply with requirements of referenced plaster application standards and recommendations of plaster manufacturer for environmental conditions before, during, and after plaster application.

D. Protect contiguous work from soiling and moisture deterioration caused by plastering. Pro-vide temporary covering and other provisions necessary to minimize harmful spattering of plaster on other work.

E. Remove masking tape and clean all adjacent surfaces at the end of each workday. Do not leave masking tape or waste materials in place for more than thirty-six hours.

1.09 DELIVERY, STORAGE AND HANDLING

A. Deliver cementitious materials to Project site in original packages, containers, or bundles, labeled with manufacturer's name, product brand name, and lot number.

B. Store materials inside, under cover, and dry, protected from weather, direct sunlight, surface contamination, aging, corrosion, and damage from construction traffic and other causes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Expanded-Metal Lath:
   1. Alabama Metal Industries Corp. (AMICO).
   2. Dale//Incor Industries, Inc.
   3. Dietrich Industries, Inc.
   4. National Gypsum Co.
   5. Unimast, Inc.
   6. United States Gypsum Co.

B. Metal Accessories:
   1. Alabama Metal Industries Corp. (AMICO).
   2. Dale//Incor Industries, Inc.
   3. Metalex (Keene Products).
   4. National Gypsum Co.
   5. Unimast, Inc.
   6. United States Gypsum Co.

C. Plastic Accessories:
   1. Alabama Metal Industries Corp. (AMICO).
   2. Plastic Components, Inc.
   3. Vinyl Corp.

D. Stucco:
   1. Cemex / Broco Cement
   2. Florida Stucco Corp.
   3. Highland Stucco.
   4. IPA Systems, Inc.
   5. United States Gypsum Co.

E. Substitutions: See Section 016000 - Product Requirements.

2.02 PLASTER MATERIALS

A. Portland Cement, Aggregates, and Other Materials: In accordance with ASTM C 926.

B. Portland Cement: ASTM C 150, Type I.
   1. For finish coat: Gray color.

C. Masonry Cement: ASTM C 91 Type N.

D. Lime: ASTM C 206, Type S.

E. Aggregate: In accordance with ASTM C 926.

F. Water: Clean, fresh, potable and free of mineral or organic matter that could adversely affect plaster.

G. Plaster Mix Reinforcement: Glass fibers, chopped to 1/2 inch (13 mm) nominal length, alkali resistant.

H. Structo-Lite Gypsum Plaster: Contains mill-mixed perlite aggregate. Type: Regular -- for gyp-sum or metal lath; Masonry -- for high-suction unit masonry; Type R or S for specific UL-listed assemblies. Meet ASTM C28.

I. Color Pigment: Mineral oxide type, color as selected.

J. Finish Aggregate: to match existing

K. Bonding Agent: As recommended by manufacturer for bonding to specified substrate.

2.03 METAL LATH

A. Expanded-Metal Lath: Comply with ASTM C 847 for material, type, configuration, and other characteristics indicated below.

B. Material: Fabricate expanded-metal lath from sheet metal conforming to the following:
   1. Galvanized Steel: Structural-quality, zinc-coated (galvanized) steel sheet complying with ASTM A 653, G60 (ASTM A 653M, Z180) minimum coating designation, unless otherwise indicated.
   2. Diamond-Mesh Lath: Comply with the following requirements:
      a. Configuration: Flat.
         1) Weight: 3.4 lb/sq. yd. (1.8 kg/sq. m).
   3. Paper Backing: Provide the following material factory bonded to back of lath. Comply with FS UU-B-790, Type I, grade and style as indicated below:
      a. Vapor-Retardant Paper: Grade B, Style 1A.

2.04 ACCESSORIES

A. General: Comply with material provisions of ASTM C 1063 and the requirements indicated below; coordinate depth of accessories with thicknesses and number of plaster coats required.

1. Galvanized Steel Components: Fabricated from zinc-coated (galvanized) steel sheet complying with ASTM A 653, G40 (ASTM A 653M, Z90) minimum coating designation.
2. Zinc-Alloy Components: ASTM B 69, 99 percent pure zinc.
3. Plastic Components: ASTM D 4216, high-impact polyvinyl chloride (PVC) for building products.

B. Metal Corner Reinforcement: Expanded, large-mesh, diamond-metal lath fabricated from zinc-alloy or welded-wire mesh fabricated from 0.0475-inch- (1.2-mm-) diameter, zinc-coated (galvanized) wire and specially formed to reinforce external corners of portland cement plaster on exterior exposures while allowing full plaster encasement.

C. Cornerbeads: Small nose cornerbeads fabricated from the following metal, with expanded flanges of large-mesh diamond-metal lath allowing full plaster encasement.
1. Zinc Alloy: Minimum 0.0207 inch (0.53 mm) thick.

D. Casing Beads: Square-edged style, with expanded flanges of the following material:
1. Zinc Alloy: Minimum 0.0207 inch (0.53 mm) thick.

E. Curved Casing Beads: Square-edged style, fabricated from aluminum coated with clear plastic, preformed into curve of radius indicated.

F. Control Joints: Prefabricated, of material and type indicated below:
1. Zinc Alloy: Minimum 0.0207 inch (0.53 mm) thick.
2. One-Piece Type: Folded pair of non-perforated screeds in M-shaped configuration, with expanded or perforated flanges.
a. Provide removable protective tape on plaster face of control joints.

G. Foundation Sill (Weep) Screed: Manufacturer's standard profile designed for use at sill plate line to form plaster stop and prevent plaster from contacting damp earth, fabricated from zinc-coated (galvanized) steel sheet.

H. Lath Attachment Devices: Material and type required by ASTM C 1063 for installations indicated.
1. Screw attachment to metal framing: Material and type required by ASTM C 954. Corrosion resistant steel drill screws for attachment to steel members from 0.33 inches (0.84 mm) to 0.112 inches (2.48 mm) thick, 1 5/8-inch size, truss head.

2.05 PLASTER MIXES

A. Over Solid Bases: Two-coat application, mixed and proportioned in accordance with ASTM C 926.

B. Over Metal Lath: Three-coat application, mixed and proportioned in accordance with ASTM C 926.

C. Pre-mixed Plaster Materials: Mix in accordance with manufacturer's instructions.

D. First Coat over Metal Lath or dense clay tile:
1. One part portland cement.
2. Minimum 0 and maximum ¾-part hydrated lime.
3. Minimum 2-1/2 and maximum 4 parts aggregate, per sum of cementitious materials.
4. Reinforcement at 1-1/2 lbs (0.7 kg) per sack of cement.

E. First Coat over Concrete Masonry (CMU), porous brick or porous clay tile:
1. One part portland cement.
2. Minimum 3/4 and maximum 1½ -part hydrated lime.
3. Minimum 2-1/2 and maximum 4 parts aggregate, per sum of cementitious materials.
4. Reinforcement at 1-1/2 lbs (0.7 kg) per sack of cement.

F. Second Coat: Same as first coat, except minimum 3 parts and maximum 5 parts aggregate.

G. Finish Coat:

1. One part Portland cement.
2. Minimum 3/4 and maximum 1-1/2 parts lime.
3. 3 parts sand, per sum of cementitious materials.
4. Finish aggregate: As specified above.

H. Mix only as much plaster as can be used prior to initial set.

I. Add color pigments to finish coat in accordance with manufacturer's instructions.

J. Mix materials dry, to uniform color and consistency, before adding water.

K. Add air entrainment admixtures to all coats to provide 5-7 percent entrainment.

L. Protect mixtures from freezing, frost, contamination, and excessive evaporation.

M. Do not re-temper mixes after initial set has occurred.

N. Stucco Finish Coat: Add water only; comply with stucco manufacturer's written instructions.

2.06 MISCELLANEOUS MATERIALS

A. Water for Mixing and Finishing Plaster: Potable.

B. Bonding Agent: ASTM C 932.

C. Dash-Coat Material: 2 parts portland cement to 3 parts fine sand, mixed with water to a mushy-paste consistency.

D. Steel drill screws complying with ASTM C 1002 for fastening metal lath to wood or steel members less than 0.033 inch (0.84 mm) thick.

E. Steel drill screws complying with ASTM C 954 for fastening metal lath to steel members 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

2.07 MIXING

A. Mechanically mix cementitious and aggregate materials for plasters to comply with applicable referenced application standard and with recommendations of plaster manufacturer.

PART 3 - EXECUTION

3.01 PREPARATION

A. General: Perform preparation and cleaning procedures in accordance with manufacturer’s recommendations.
   1. Provide undercoats and primer as recommended for each type of substrate.

B. Provide masking or other protection prior to surface coating operations. Remove protection immediately following completion of each area.

C. Flashing: Refer to Division 7 Sections for installing flashing as indicated.

3.02 PLASTERING

A. Apply premixed plaster in accordance with manufacturer's instructions.

B. Apply plaster in accordance with ASTM C 926.

C. Two-Coat Application (over solid bases only):
   1. Apply first coat to nominal thickness of 3/8 inch (9 mm).
   2. Apply finish coat to nominal thickness of 1/8 inch (3 mm).

D. Three-Coat Application Over Metal Lath:
   1. Apply first coat to a nominal thickness of 3/8 inch (9 mm).
   2. Apply second coat to a nominal thickness of 3/8 inch (9 mm).
   3. Apply finish coat to a nominal thickness of 1/8 inch (3 mm).

E. Three-Coat Application Over Solid Bases:
   1. Apply first coat to a nominal thickness of 1/4 inch (6 mm).
   2. Apply second coat to a nominal thickness of 1/4 inch (6 mm).
   3. Apply finish coat to a nominal thickness of 1/8 inch (3 mm).

F. In exterior work, scribe contraction joints through entire plaster application at 10 feet (3 m) on center each way.

G. Moist cure base coats.

H. Apply second coat immediately following initial set of first coat.

I. After curing, dampen previous coat prior to applying finish coat.

J. Avoid excessive working of surface. Delay troweling as long as possible to avoid drawing excess fines to surface.

K. Moist cure finish coat for minimum period of 48 hours.

L. Do not use materials that are frozen, caked, lumpy, dirty, or contaminated by foreign materials.

M. Do not use excessive water in mixing and applying plaster materials.

N. Sequence plaster application with installation and protection of other work so that neither will be damaged by installation of other.

O. Plaster flush with metal frames and other built-in metal items or accessories that act as a plaster ground, unless otherwise indicated. Where interior plaster is not terminated at metal frame by casing beads, cut base coat free from metal frame before plaster sets and groove finish coat at junctures with metal.

P. Corners: Make internal corners and angles square; finish external corners flush with corner beads on interior work, square and true with plaster faces on exterior work with at least 1/8 inch coverage of the metal.

Q. Molding and trim: Install adhering over the plaster brown coat.

R. Separation shall be provided where plaster abuts dissimilar materials or openings.

S. Always terminate day's work against edge or joint.

3.03 INSTALLATION OF LATH AND FURRING, GENERAL

A. Standards: Comply with ML/SFA 920, "Guide Specifications for Metal Lathing and Furring," and with requirements of ASTM C 1063.

B. Install supplementary framing, blocking, and bracing at terminations in work and for support of fixtures, equipment services, heavy trim, grab bars, handrails, furnishings, and similar work to comply with details indicated or, if not otherwise indicated, to comply with applicable written instructions of lath and furring manufacturer.

C. Isolation: Where lathing and metal support system abuts building structure horizontally and where partition or wall abuts overhead structure, sufficiently isolate from structural movement to prevent transfer of loading from building structure. Install slip- or cushion-type joints to absorb deflections but maintain lateral support.
   1. Frame both sides of control joints independently and do not bridge joints with furring and lathing or accessories.

D. Install additional framing, furring, runners, lath, and beads, as required to form openings and frames for other work as indicated. Coordinate support system for proper support of framed work that is not indicated to be supported independently of metal furring and lathing system.

E. Install metal lath for the following applications where plaster base coats are required. Provide appropriate type, configuration, and weight of metal lath selected from materials indicated that comply with referenced ML/SFA specifications and ASTM lathing installation standards.
   1. Exterior sheathed wall surfaces using 3.4-lb/sq. yd. (1.8-kg/sq. m) minimum weight, diamond-mesh lath.

3.04 INSTALLATION OF PLASTERING ACCESSORIES

A. General: Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Miter or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and in alignment during plastering. Install accessories of type indicated at following locations:
   1. External Corners in Non-Public Areas: Install corner reinforcement at external corners.
   2. External Corners in Public Areas: Bend lath around external angles without using cornerbeads or reinforcement.
   3. Terminations of Plaster in Non- Public Areas: Install casing beads, unless otherwise indicated.
   4. Control Joints in Non-Public Areas: Install at locations indicated or, if not indicated, at locations complying with the following criteria and approved by Architect:
      a. Where an expansion or contraction joint occurs in surface of construction directly behind plaster membrane.
      b. Distance between Control Joints: Not to exceed 18 feet (5.4 m) in either direction or a length-to-width ratio of 2-1/2 to 1.
      c. Wall Areas: Not more than 144 sq. ft. (13 sq. m).
      d. Horizontal Surfaces: Not more than 100 sq. ft. (9 sq. m) in area.
      e. Where plaster panel sizes or dimensions change, extend joints full width or height of plaster membrane.

3.05 TOLERANCES

A. Maximum Variation from True Flatness: 1/8 inch in 10 feet (3 mm in 3 m) unless otherwise indicated in the Drawing Documents.

B. Flat Surface Tolerances for Non-Public Areas: Do not deviate more than plus or minus 1/8 inch in 10 feet (3 mm in 3 m) from a true plane in finished plaster surfaces, as measured by a 10-foot (3-m) straightedge placed at any location on surface.

3.06 CUTTING AND PATCHING

A. Cut, patch, replace, repair, and point up plaster as necessary to accommodate other work. Repair cracks and indented surfaces. Point-up finish plaster surfaces around items that are built into or penetrate plaster surfaces. Repair or replace work to eliminate blisters, buckles, check cracking, dry outs, efflorescence, excessive pinholes, and similar defects. Repair or replace work as necessary to comply with required visual effects.

3.07 CLEANING AND PROTECTING

A. Remove temporary covering and other provisions made to minimize spattering of plaster on other work. Promptly remove plaster from door frames, windows, and other surfaces not to be plastered. Repair surfaces stained, marred or otherwise damaged during plastering work. When plastering work is completed, remove unused materials, containers, equipment, and plaster debris.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure plaster work is without damage or deterioration at the time of Substantial Completion.

END OF SECTION

SECTION 095100

ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

C. Perimeter trim and miscellaneous accessories.

1.02 RELATED SECTIONS

A. Section 083100 - Access Doors and Panels: Access panels.

B. Section 092116 - Gypsum Board Assemblies: Acoustical insulation, acoustical sealant. Adjust construction.

C. Division 23 - Mechanical: Fire suppressions sprinklers and diffusers.

D. Division 26 - Electrical: Fire alarm system, speakers and light fixtures.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM C 635 - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.

C. ASTM C 636/C 636M - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.

D. ASTM C 665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

E. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

F. ASTM E 580/E 580M - Standard Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Seismic Restraint.

G. ASTM E 1264 - Standard Classification for Acoustical Ceiling Products.

H. ASTM E 1477 - Standard Test Method for Luminance Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.

I. CISCA (AC) - Acoustical Ceilings: Use and Practice; Ceilings & Interior Systems Construction Association.

J. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Do not install acoustical units until after interior wet work is dry.

1.05 SUBMITTALS

A. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling, flame spread rating, and smoke developed rating.

B. Product Data: Provide data on suspension system components and acoustical units.

C. Samples: Submit two samples 8 x 8 inch (200 x 200 mm) in size illustrating material and finish of acoustical units.

D. Samples: Submit two samples each, 6 inches long, of suspension system main runner.

E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer's unopened packaging and store unopened in fully enclosed space until ready for installation. Protect products from exposure to sunlight, moisture, and mechanical damage.

B. Handle acoustical panels carefully to avoid soiling exposed surfaces or damaging surfaces and edges.

1.07 QUALITY ASSURANCE

A. Fire-Resistive Assemblies: Complete assembly listed and classified by UL for the fire resistance indicated.

B. Surface Burning Characteristics: Tested per ASTM E84 and complying with ASTM E 1264 for Class A products; Flame spread: 25 or less; Smoke developed: 50 or less.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 5 years documented experience.
   1. Single-Source Responsibility: Provide acoustical panel units and grid components from a single manufacturer.

1.08 WARRANTY

A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace acoustical panels that fail within the warranty period. Failures include, but are not limited to:
   1. Acoustical Panels: Sagging and warping
   2. Grid System: Rusting and manufacturer's defects

B. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.09 FIELD CONDITIONS

A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

1.10 PROJECT CONDITIONS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

C. Install acoustical units after interior wet work is dry.

PART 2 - PRODUCTS

2.01 ACOUSTICAL UNITS

A. Manufacturers:
   1. Armstrong World Industries, Inc: www.armstrong.com.
   2. Substitutions: Not permitted.

B. Acoustical Ceiling Tile: Painted mineral fiber, with the following characteristics:
   1. Size: 24 x 24 inches (600 x 600 mm), unless noted otherwise on drawings.
   2. Thickness: 5/8 inches (15 mm).
   3. Edge: Square.
   4. Surface Color: White.
   5. Surface Pattern: Perforated, regularly spaced large holes.
   6. Product: As indicated on drawings.
   7. Suspension System: Exposed grid Type Prelude MX 15/16" Exposed Tee.

2.02 SUSPENSION SYSTEM(S)

A. Manufacturers:
   1. Same as for acoustical units.

B. Components: All main beams and cross tees shall be commercial quality hot-dipped galvanized (galvanized steel, aluminum, or stainless steel) as per ASTM A 653. Main beams and cross tees are double-web steel construction with 15/16in type exposed flange design. Exposed surfaces chemically cleansed, capping pre-finished galvanized steel (aluminum or stainless steel) in baked polyester paint. Main beams and cross tees shall have rotary stitching (exception: extruded aluminum or stainless steel).

C. Color: White and match the actual color of the selected ceiling tile, unless noted otherwise.

D. High Humidity Finish: Comply with ASTM C 635 requirements for Coating Classification for Severe Environment Performance where high humidity finishes are indicated.

E. Design based on: Prelude MX 15/16" Exposed Tee as manufactured by Armstrong World Industries, Inc.

F. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

G. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least time three design load, but not less than 12 gauge.

H. Edge Moldings and Trim: Metal or extruded aluminum of types and profiles indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations, including light fixtures, that fit type of edge detail and suspension system indicated. Provide moldings with exposed flange of the same width as exposed runner.

2.03 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Perimeter Moldings: Same material and finish as grid.
   1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
   2. At Concealed Grid: Provide concealed molding.

C. Acoustical Insulation: Specified in Section 092116.
   1. Thickness: 2 inch (50 mm).
   2. Size: To fit acoustical suspension system.

D. Gypsum Board: Fire rated type; 5/8 inch (15 mm) thick, ends and edges square, paper faced.

E. Sealant For Perimeter Moldings: Specified in Section 079200.

F. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.

C. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations.

3.02 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C 636 and manufacturer's instructions and as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.

D. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

E. Provide hanger clips during steel deck erection. Provide additional hangers and inserts as required.

F. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

H. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

I. Support fixture loads using supplementary hangers located within 6 inches (150 mm) of each corner, or support components independently.

J. Do not eccentrically load system or induce rotation of runners.

K. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Use longest practical lengths.

2. Miter corners.

L. Form expansion joints as detailed. Form to accommodate plus or minus 1 inch (25 mm) movement. Maintain visual closure.

M. Install light fixture boxes constructed of acoustical panel above light fixtures in accordance with fire rated assembly requirements and light fixture ventilation requirements.

3.03 INSTALLATION - ACOUSTICAL UNITS - GENERAL

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Fit border trim neatly against abutting surfaces.

D. Install units after above-ceiling work is complete.

E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

F. Cutting Acoustical Units:
1. Cut to fit irregular grid and perimeter edge trim.
2. Make field cut edges of same profile as factory edges.
3. Double cut and field paint exposed reveal edges.

G. Where round obstructions and bullnose concrete block corners occur, provide preformed closures to match perimeter molding.

H. Install hold-down clips on each panel to retain panels tight to grid system; comply with fire rating requirements.

I. Install hold-down clips on panels within 20 ft (6 m) of an exterior door.

3.04 TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.05 CLEANING AND PROTECTION

A. Clean exposed surfaces of acoustical panel ceilings, including suspension system and edge trim, complying with manufacturer's written instructions for cleaning of minor finish damage. Replace acoustical panels that cannot be cleaned to an appearance matching unmarred panels.

B. Protect installed acoustic panel ceilings until completion of project.

END OF SECTION

SECTION 096500

RESILIENT FLOORING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Resilient base.

B. Installation accessories.

1.02 RELATED SECTIONS

A. Section 033000 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors.

B. Section 092116 - Gypsum Board Assemblies: Substrate for installation.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM F 1861 - Standard Specification for Resilient Wall Base.

1.04 SUBMITTALS

A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

B. Shop Drawings: Indicate seaming plan.

C. Selection Samples: Submit manufacturers complete set of color samples for Architect's initial selection.

D. Verification Samples: Submit 4 samples, 4 x 4 inch (100 x 100 mm) in size illustrating color and pattern for each resilient flooring product specified.

E. Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of sub-floor is acceptable.

F. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 016000 - Product Requirements, for additional provisions.
   2. Extra Wall Base: 20 linear feet or quantity equivalent to 5% of installed product of each type and color.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store products in manufacturers sealed packages. Materials should be stored under cover and protected from the elements. Allow products to acclimate to room conditions 48 hours prior to installation.

B. Protect roll materials from damage by storing on end.

1.06 QUALITY ASSURANCE

A. Slip Resistance: Walking surfaces shall have a 1) Static coefficient of friction (COF) per ASTM C1029-07E1 under dry conditions of a minimum of 0.6 for slopes of less than 1:21 and a minimum of 0.8 for slopes exceeding 1:21, and 2) dynamic coefficient of friction (DCOF) per ANSI 137.1-2012 Section 9.6 DCOF ACUTEST under wet conditions of not less than 0.42.

1.07 FIELD CONDITIONS

A. Maintain temperature in storage area per manufacturer's standards.

B. Store materials for not less than 48 hours prior to installation in area of installation at ambient room temperature to achieve temperature stability.

PART 2 - PRODUCTS

2.01 RESILIENT BASE

A. Resilient Base: ASTM F 1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove, and as follows:
   1. Height: 4 inch (100 mm) unless otherwise noted in drawings.
   2. Thickness: 0.125 inch (3.2 mm) (3.2 mm) thick.
   3. Finish: Satin.
   4. Length: Roll.
   5. Color: Color as selected from manufacturer's standards.
   6. Accessories: Premolded external corners and internal corners.
   7. Manufacturers:
      a. Johnsonite, Inc: www.johnsonite.com.
      b. Roppe Corp: www.roppe.com.
      c. Substitutions: See Section 016000 - Product Requirements.

2.02 ACCESSORIES

A. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.

B. Moldings and Edge Strips: Metal unless noted otherwise in drawings.

C. Filler for Coved Base: Plastic.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.

B. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Clean substrate.

B. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION

A. Starting installation constitutes acceptance of substrate conditions.

B. Install in accordance with manufacturer's instructions.

C. Spread only enough adhesive to permit installation of materials before initial set.

D. Fit joints tightly.

3.04 RESILIENT BASE

A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.

B. Install base on solid backing. Bond tightly to wall and floor surfaces.

C. Scribe and fit to door frames and other interruptions.

3.05 CLEANING

A. Remove excess adhesive from floor, base, and wall surfaces without damage.

B. Clean, seal, and wax in accordance with manufacturer's instructions.

C. Clean, seal, and wax resilient flooring products in accordance with manufacturer's instructions.

END OF SECTION

SECTION 099000

PAINTS AND COATINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Surface preparation and field application of paints and stains on exposed substrates, which are not factory finished.

B. Surface preparation and field application of paints and stains on factory finished items as indicated on Drawings.

1.02 RELATED SECTIONS

A. Section 062000 Finish Carpentry. Wood substrate.

B. Section 079200 Joint Sealants.

C. Section 092116 Gypsum Board Assemblies: Wall substrate. Preparation of walls to receive Level 5 finish for application of wall coverings and wall coverings-graphic.

D. Section 092400 Portland Cement Plaster: Plaster substrate.

E. Section 097212 Wall Coverings, Graphic.

F. Section 099416 Themed Painting: Finish treatment.

G. Section 101900 Exhibits and Graphics: Walls to receive Level 5 finish for application of vinyl graphics and wall coverings-graphic.

1.03 REFERENCES

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM D 16 - Standard Terminology for Paint, Coatings, Materials, and Applications.

C. CGBSC – California Green Building Standards Code (CALGreen).

1.04 DEFINITIONS

A. Conform to definitions of terms in ASTM D 16 in interpreting requirements of this specification section.

1.05 SUBMITTALS

A. See Section 013000 - Submittals, for submittal procedures.

B. Product Data: Provide manufacturer's printed product data on all coatings specified, including preparation and application instructions.

C. Verification Samples: Provide two samples of not less than 12 inches (300 mm) square illustrating selected colors and textures for each color specified.
   1. Prepare samples to show bare, prepared surface and each successive coat.
   2. Label each sample with coating name and number.

1.06 MOCK-UPS

A. Prior to beginning installation, Contractor shall provide jobsite samples, located as directed by the Owner, of each variation of material.

B. Provide at a minimum, 4 feet (1.2 m) long by 4 feet (1.2 m) wide of each coating system to demonstrate surface preparation, verification of products, colors, textures, and sheens textures, and installation quality.

C. Contractor must achieve approval of the mock-ups by the Architect prior to the start of construction. Provide additional mock-ups as required to receive Architect's approval.

D. Keep approved mock-ups intact as the standard for evaluating the completed work.
   1. Approved samples may be incorporated into the finished work at the approval of the Owner.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers. Labels shall include manufacturer's name, type of coating, brand name, lot number, estimated coverage, surface preparation requirements, drying time, cleanup instructions, color designation, and instructions for mixing.

1.08 EXTRA MATERIALS

A. See Section 016000 - Product Requirements, for additional provisions.

B. Deliver to Owner 1 gallon (4 liters) new, unopened can of each finish paint in each color required for Project; mark each container with color and locations where paint was used, without obscuring manufacturer's label.

C. Deliver to Owner 3 sets of draw down card selection of all colors used on project.

1.09 ENVIRONMENTAL REQUIREMENTS

A. All products shall be in compliance with EPA and the State of California regulations for VOC and lead content.

B. Do not apply products of this section outside acceptable range of conditions as specified by paint manufacturer.

C. Do not apply coatings during rain or snow or when humidity is in excess of manufacturer's recommended limit.

1.10 SUSTAINABLE REQUIREMENTS

A. Architectural Paints and Coatings shall comply with table 5.504.4.2, of CGBSC, unless more stringent local limits apply.

B. Adhesives and Sealants used in the Work shall meet the requirements of CALGREEN, including section 5.504.4.1.

C. Adhesives, adhesive bonding primers, adhesive primers, sealant primers, sealants and caulks used in the Work shall meet the requirements of local or regional air pollution control or Air Quality Management District rules, where applicable, or SQAQMD RULE 1168 VOC limits, as shown in Table 5.504.4.1, and 5.04.4.2;(reference CGBSC 5.504.4.1).

D. Aerosol adhesives, and smaller unit sizes of adhesives, and sealant or caulking compounds (in units of product, less packaging, which do not weigh more than one pound and do not consist of more than sixteen (16) fluid ounces, shall comply with statewide VOC standards and other requirements, including prohibitions on use of certain toxic compounds, of California Code of regulations, Title 17, commencing with Section 94507.

1.11 QUALITY ASSURANCE

A. Owner's Representative might request inspection and approval of each surface to be painted and of each coat of paint before application of succeeding coat. If this is required, notify Owner's Representative when a prepared surface and a particular coat is ready for inspection.

B. Should the dry film thickness of paint be less than 75 percent of the specified minimum, the Contractor will be required to recoat the work in question at his own expense.

C. Paints shall not contain lead as an ingredient; refer to General Contract Conditions, PART II — ENVIRONMENTAL, SAFETY AND HEALTH PROVISIONS.

1.12 SCOPE

A. The following list includes, but does not limit, the items to be prepared, primed and/or painted, except as otherwise noted:
   1. Interior and exterior exposed steel and miscellaneous ferrous metal items: columns and steel jackets, beams, trusses, purlins, girts, frames, plate platforms, stairs, ladders, railings, curbs, trench and pit frames and covers, guard posts, manhole frames and covers, hydrants, post indicators, hose houses, and all brackets, supports, hangers and fasteners for mechanical, piping, instrumentation and electrical facilities.
   2. Exposed electrical conduits in Division 26.
   3. Exposed Fire Protection piping and installations Division 21, unless scheduled.
   4. Exposed mechanical ducts in Division 23.
   5. Galvanized steel exposed to public view.

B. Exposed wood surfaces are to receive paint or stain unless otherwise noted. Refer to Contract Documents for type, color, and location.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. PPG Architectural Coatings, One PPG Place, Pittsburgh, PA 15272, 888-774-4332, www.ppgpro.com
   1. National Account Manager Contact Wayde Hayley 416-557-8386.
   2. Architect Manager Contact Drew Harris 618-381-5307.

B. Substitutions: Comparable products by Sherwin Williams.
   1. Refer to Section 016000 for substitution procedures.

2.02 COLORS AND SHEEN

A. Colors and Sheen: Refer to Material Legend on drawings.

2.03 MATERIALS

A. Coatings: Ready mixed, except for field catalyzed coatings; having good flow and brushing properties and consistent drying or curing behavior, free of sags and streaks.

B. Accessory Materials: Paint thinners and other materials recommended by coatings manufacturer as necessary to achieve finishes specified.

C. Patching and Surface Preparation: Latex fillers as recommended by coatings manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that site environmental conditions are appropriate and substrates are in proper condition to receive work of this section.

B. Verify that shop applied primers are compatible with specified finish coats.

C. Measure moisture content of surfaces using an electronic moisture meter. Do not begin application of coatings unless moisture content of surfaces is below the following maximum values:
   1. Wood surfaces: 19 percent.

3.02 PREPARATION

A. Remove or mask electrical plates, hardware, light fixture trim, and similar fittings prior to beginning painting operations.

B. Correct defects and clean surfaces affecting work of this section. Remove existing coatings that are flaking or otherwise in unacceptable condition to receive paint.

C. Seal with shellac or other coating acceptable to paint manufacturer any marks or defects that might bleed through paint finishes.

D. Remove mildew from impervious surfaces by scrubbing with solution of trisodium phosphate and bleach. Rinse with clean water and allow substrate to dry.

E. Wood for Opaque Finish: Remove dirt and foreign matter. Patch knots, pitch pockets, and other surface imperfections with patching compound and seal with sealer recommended by paint manufacturer.

F. Wood for Transparent Finish: Remove dirt and foreign matter. Seal knots and pitch pockets with sealer recommended by stain manufacturer. Fill nail holes and other surface imperfections with tinted caulking compound after sealer has been applied.

G. Galvanized Metal Surfaces: Remove oils and wash with Devprep 88 Cleaner, 3 parts clean water to 1 part Devprep 88. Allow for a five to ten minute dwell time and the power wash off solution using a minimum of 2000 p.s.i. Allow surface to dry. Brush Blast in accordance with SSPC-SP7 galvanized surfaces to be coated where the substrate will be subject to intermittent or consistent moisture. During Brush Blast take care not to remove galvanizing during this process.

3.03 APPLICATION

A. Apply paint products in accordance with manufacturer's printed instructions. Do not apply coatings to surfaces that are not dry.

B. Apply each coat to uniform thickness and finish, with each coat slightly darker than preceding coat. Allow each coat to dry thoroughly before applying next coat.

C. Sand wood and metal surfaces lightly between coats. Vacuum surfaces free of loose particles prior to application of next coat.

3.04 CLEANING AND PROTECTION

A. Keep project premises free of painting-related debris. Collect material that may constitute a fire hazard, place in closed metal containers, and remove daily from site.

B. Protect work adjacent to painting operations from paint spatters and spills. Immediately remove paint that falls on finished surfaces not scheduled to receive paint, using materials and techniques that will not damage affected surfaces.

3.05 SCHEDULE: LOW VOC, CALGREEN COMPLIANT

A. Galvanized Metal and Carbon Steel where high performance is required: (Do not paint galvalume surfaces.)
   1. Galvanized surfaces shall be cleaned using PPG Prep 88 mixed three parts clean water to one part PPG Prep 88. Apply solution to surface allow for a five to ten minute dwell time and then power wash clean using a minimum of 2000 p.s.i. Carbon Steel surfaces shall be prepared in accordance with SSPC-SP6 Commercial Blast Cleaning.
   2. Aliphatic Urethane Enamel
      a. Primer Galvanized: PPG 94-109 Multiprime EFD Epoxy Primer (340 g/L VOC) @ 4.0 - 6.0 mils dft.
      b. Primer Carbon Steel: PPG 97-694 Metalhide 2000 Inorganic Zinc Coating (466 g/L VOC) @ 2.0-5.0 mils dft.
      c. Intermediate Coat Galvanized & Carbon Steel: PPG 95-245 Pitt-Guard Rapid Coat DTR Epoxy Mastic (263 g/L VOC) @ 4.0 - 7.0 mils dft.
      d. Top Coat: PPG 95-812 Pitthane Ultra Aliphatic Urethane Gloss Enamel (241 g/L VOC) @ 2.0 –3.0 mils dft.

B. Metal Substrates, Including Machinery, Equipment and Fixtures, Queue Rails and Handrails at Ramps, Hollow Metal Doors and Frames:
   1. These surfaces shall be cleaned in accordance with SSPC-SP1 Solvent Cleaning followed by SSPC-SP3 Power Tool Cleaning.
   2. Aliphatic Urethane
      a. Primer: PPG 95-245 Pitt-Guard Rapid Coat DTR Epoxy Mastic (263 g/L VOC) @ 4.0 - 7.0 mils dft.
      b. Top Coats: PPG 95-812 Pitthane Ultra Aliphatic Urethane Gloss Enamel (241 g/L VOC) @ 2.0 –3.0 mils dft.

C. Structural Steel, Exterior Application:
   1. These surfaces shall be prepared in accordance with SSPC-SP6 Commercial Blast Cleaning.
   2. Aliphatic Urethane
      a. Primer: PPG 97-694 Pitt-Guard 2000 Inorganic Zinc Coating (466 g/L VOC) @ 2.0-5.0 mils dft.
      b. Intermediate Coat: PPG 95-245 Pitt-Guard Rapid Coat DTR Epoxy Mastic (263 g/L VOC) @ 4.0 - 7.0 mils dft.
      c. Finish Coat: PPG 95-812 Pitthane Ultra Aliphatic Urethane Gloss Enamel (241 g/L VOC) @ 2.0 –3.0 mils dft.

D. Structural Steel, Semi-Gloss Epoxy Interior, Dry Areas:
   1. These surfaces shall be prepared in accordance with SSPC-SP6 Commercial Blast Cleaning.
   2. Eopxy Coating System
      a. Primer: PPG 97-694 Pitt-Guard 2000 Inorganic Zinc Coating (466 g/L VOC) @ 2.0-5.0 mils dft.
      b. Top Coat: 2 Coats of PPG 97-145 Pitt-Guard DTR Epoxy Mastic (128 g/L VOC) @ 4.0-7.0 mils dft.

E. Interior Concrete Masonry Units Dry Areas:
   1. Waterborne Acrylic Resin:
      a. Primer: 1 coat of PPG 16-90 Heavy Duty Block Filler (67 g/L VOC) @ 7-14.5 mils dft.
      b. Top Coat: 2 Coats of PPG 9-500 Pure Performance 100% Acrylic Semi-Gloss Finish (0 g/L VOC) @ 1.4 mils dft.

F. Interior Gypsum Board Dry Areas:
   1. Waterborne Acrylic Resin:
      a. Primer: 1 coat of PPG 17-921 Seal Grip Interior/Exterior Acrylic Universal Primer/Sealer (84 g/L VOC) @ 1.6 mils dft.
      b. Top Coat: 2 Coats of PPG 9- 100-500 Series, Pure Performance 100% Acrylic Finish (0 g/L VOC) @ 1.4 mils dft. Sheen as indicated on Drawings.

G. Interior Gypsum Board Ceilings Dry Areas:
   1. Waterborne Acrylic Resin:
      a. Primer: 1 coat of PPG 17-921 Seal Grip Interior/Exterior Acrylic Universal Primer/Sealer (84 g/L VOC) @ 1.6 mils dft.
      b. Top Coat: 2 Coats of PPG 9- 100-500 Series, Pure Performance 100% Acrylic Finish (0 g/L VOC) @ 1.4 mils dft. Sheen as indicated on Drawings.

H. Wood Substrates, Exterior:
   1. Opaque Stain, Exterior Acrylic Solid Color:
      a. 2 coats of PPG PP1975 Acri-Shield Acrylic Solid Color Stain (169 g/L VOC).
   2. Semi-Transparent Stain:
      a. 2 coats of PPG Flood CWF-UV 5 Oil Low VOC (345 g/L VOC)

I. Wood Substrates, Interior and Wood Doors:
   1. Interior Polyurethane Satin Varnish:
      a. Primer: PPG 44500 Olympic Interior Wood Stain (<250 g/L VOC).

b. Intermediate: 1 coat of PPG Olympic 42786 Water-Based Satin Polyurethane (<250 g/L VOC)
c. Finish: 1 coat of PPG Olympic 42786 Water-Based Satin Polyurethane (<250 g/L VOC)

J. Wood Substrates, Exterior surfaces for coating or re-coating:
1. Primer: 1 coat PPG Hydrosealer #6001 (100 g/L VOC).
2. Top Coats: 2 coats of PPG: 6-610XI Speedhide Exterior 100% Acrylic Flat (<50 g/L VOC).

K. Wood Substrates (Trim and Wood Doors), Exterior surfaces for coating:
1. Primer: 1 coat PPG Hydrosealer #6001 (100g/L VOC).
2. Top Coats: 2 coats of PPG 90-1210 Pitt-Tech Plus DTM Semi-Gloss (90 g/L VOC).

L. Cement Stucco, Exterior:
1. Exterior Acrylic Finish
a. Primer: 1 coat of PPG 17-921 Seal Grip Int/Ext Acrylic Universal Primer/Sealer (84 g/L VOC) @ 1.6 mils dft.
b. Top Coats: 2 coats of PPG 6-900XI Speedhide Exterior 100% Acrylic Semi-Gloss Finish (<50 g/L VOC) @ 1.4 mils dft.

M. Concrete Stain
1. Waterborne penetrating Concrete Stain
a. Lithochrome Tintura Stain with manufacturer's recommended sealer. Apply one coat to achieve translucent appearance.

N. Clear Concrete Sealer (Interior Concrete Floors):
1. Epoxy Two Component
a. PPG: Primer and Top Coat, Amerlock Sealer.
b. Sherwin Williams: Primer, Sherwin Williams, SW General Polymers 3579 Clear. Top Coat, Sherwin Williams, SW General Polymers 3744 Clear.

O. Amusement Park Ride Touch-Up Paint: Surface preparation and coating application as recommended by Ride Manufacturer.
1. Prime coat: GEHOPON-E9-Primer, spray applied, total dry film thickness at 100-160 µ NDFT (Nominal Dry Film Thickness according to DIN EN ISO 12944-5) on the whole surface, according to manufacturer's specifications.
2. Intermediate Coat: GEHOPON-E9-Intermediate, spray applied in a contrasting color to the prime coat, total dry film thickness at 100-160 µ NDFT (Nominal Dry Film Thickness according to DIN EN ISO 12944-5) on the whole surface, according to manufacturer's specifications.
3. Top Coat: WIEREGEN-M29, spray applied in a contrasting color, total dry film thickness at 100 – 150 µ NDFT (Nominal Dry Film Thickness according to DIN EN ISO 12944-5) on the whole surface, but excluding the bolted surfaces, according to manufacturer's specifications.
4. Color and Sheen: Custom colors, to match amusement park ride.

END OF SECTION

SECTION 099416

THEMED PAINTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Themed painting.

B. Finish coatings for Artificial Rockwork.

1.02 RELATED SECTIONS

A. Section 099000 Paints and Coatings: Additional requirements for primer and fillers.

B. Section 092400 Portland Cement Plaster.

C. Section 130002 Artificial Rockwork.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM D 16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.

C. ASTM D 4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.

D. NACE (IMP) - Industrial Maintenance Painting; NACE International.

E. SSPC (PM1) - Good Painting Practice: SSPC Painting Manual, Vol. 1; Society for Protective Coatings.

1.04 SUBMITTALS

A. Product Data: Manufacturer's technical data sheets for each coating. Provide data on all finishing products and special coatings specified, including VOC preparation and application content.
   1. Material analysis including vehicle type and percentage by weight and by volume of vehicle, resin, and pigment.
   2. Application instructions including mixing, surface preparation, compatible topcoats, recommended wet and dry film thickness, recommended application methods.

B. Selection Samples: Submit two sets of samples, not less than 4 x 4 inch (25 x 50 mm) in size illustrating range of colors and textures available for each surface finishing product scheduled.

C. Manufacturer's Instructions: Indicate special surface preparation procedures.

D. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.05 QUALITY ASSURANCE

A. Materials:
   1. All coating materials required by this section shall be provided by a single manufacturer, unless otherwise required or approved.
   2. Finish coatings to be compatible with paint systems as described in Section 099000.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

C. Applicator Qualifications: Company specializing in performing the work of this section with minimum 3 years of experience.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.07 MOCK-UPS

A. Prior to beginning installation, Contractor shall provide jobsite samples, located as directed by the Owner's Project Manager, of each variation of material.

B. Provide at a minimum, 4 feet (1.2 m) long by 4 feet (1.2 m) wide of each coating to demonstrate textures, colors, material finishes, and installation quality.

C. Contractor must achieve approval of the mock-ups by the Owner's Project Manager prior to the start of construction. Provide additional mock-ups as required to receive Owner's approval.

D. Keep approved mock-ups intact as the standard for evaluating the completed work.
   1. Approved samples may be incorporated into the finished work at the approval of the Owner's Project Manager.

1.08 DELIVERY, STORAGE, AND PROTECTION

A. Delivery: Deliver materials in manufacturer's original containers bearing coating name and color, material composition data, date of manufacture, legal notices if applicable, and mixing, thinning, and application instructions.
   1. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Storage:
   1. Store materials in an orderly fashion and in clean, well-closed containers with labels intact.
   2. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
   3. Paint Materials: Store at minimum ambient temperature of 45 degrees F (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in covered, ventilated area, and as required by manufacturer's instructions.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Do not apply interior coatings when humidity is in excess of manufacturer's recommended limit.

C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

D. Minimum Application Temperatures for Latex Paints: 45 degrees F (7 degrees C) for interiors; 50 degrees F (10 degrees C) for exterior; unless required otherwise by manufacturer's instructions.

E. Minimum Application Temperature for Varnish Finishes: 65 degrees F (18 degrees C) for interior or exterior, unless required otherwise by manufacturer's instructions.

F. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.

1.10 COORDINATION

A. General: Perform work in proper sequence with work of other trades to avoid damage to finished work.

B. Coordination: Where special themed coatings will be applied over base paint coatings specified in other sections, coordinate work of this section and such other sections to ensure that only approved, compatible finish coats and primers are applied.
   1. Furnish to the owner product data on all coatings demonstrating coating compatibility.

C. Refer to colored photographic references as supplied by the Architect.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: Matthews Paint Company, a division of PPG Industries, Delaware, OH, 800-323-6593, www.ppg.com/coatings/matthewspaint
   1. Mann Brothers, www.mannbrothers.com
   2. Rosco Laboratories; www.rosco.com
   3. Sherwin Williams, www.sherwinwilliams.com
   4. Substitutions: See Section 016000 - Product Requirements.

B. Provide the Manufacturer's premium grade product, top coat and primer, complying with compositional requirements and recommended for anticipated exposures and substrates.
   1. Where indicated on the material legend provide clear coating of surfaces: Matthews Paint Company Super Satin Clear #290 228SP, two component fluoropolymer.

C. For each individual system provide primer and other undercoat paint produced by the same manufacturer as finish coat.

2.02 PAINTS AND COATINGS - GENERAL

A. Paints and Coatings: Ready mixed, except field-catalyzed coatings. Prepare pigments:
   1. To a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.
   2. For good flow and brushing properties.
   3. Capable of drying or curing free of streaks or sags.

B. All coloring agents used in this project shall be as stable as possible. Any fading, discoloration or de-lamination within the warranty periods shall be unacceptable

C. All paints, pigments, inks, resins and other materials shall be compatible with adjacent materials and guaranteed not to cause deterioration or de-lamination of any materials used in fabrication.

D. No paint or pigment shall have lead content

E. Unless stated otherwise, use satin finishes.

F. Top coat colors and textures are as shown on Drawings.

G. Flammability: Comply with applicable code for surface burning characteristics.

2.03 ACCESSORY MATERIALS

A. Coatings: Ready mixed, except for field catalyzed coatings; having good flow and brushing properties and consistent drying or curing behavior, free of sags and streaks.

B. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified; commercial quality.

C. Patching Material: Latex filler as recommended by coatings manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive Work as instructed by the product manufacturer.

B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

C. Test shop-applied primer for compatibility with specified finish coats.

D. Prior to the commencement of work, examine painted surfaces scheduled for themed finishes

1. Report any unsatisfactory conditions in writing.
2. Do not apply coatings to unsatisfactory painted substrates.
3. Beginning themed painting work on an area will be construed as acceptance of surfaces in that area.

3.02 PREPARATION

A. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

B. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.

C. Remove and discard any skin formed on surface of coating in containers. Discard any containers where skin comprises 2 percent or more of the remaining material. Use only the quantities and the types of thinner recommended by manufacturer.

D. Mix materials using mechanical mixers in accordance with coating manufacturer's instructions.

3.03 APPLICATION - THEMED FINISH COATS

A. Apply products in accordance with manufacturer's instructions.

B. Employ only application equipment that is clean, properly adjusted, in good working order.

C. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

D. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

E. Apply each coat as applied on the mock-up to achieve the desired appearance.
   1. Sand wood, and metal surfaces lightly between coats as required to achieve required finish.

F. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

G. Completed coatings shall be free of defects such as runs, sags and brush marks.

H. Number of Coats and Minimum Coating Thickness: Three coats consisting of primer and two applications of top coat at minimum coating thickness recommended by the manufacturer for the substrate and application.

I. Apply paint coatings to achieve themed effects.

J. Paint electrical plates and mechanical devices not otherwise prohibited by code from being painted.

3.04 CLEANING

A. Clean work area on a daily basis; dispose of spent materials and empty containers. If requested, turn over the owner all empty coatings containers used during the course of each day.

B. Remove all trace of coatings from adjacent surfaces not scheduled to be coated. Remove by appropriate methods that do not damage surfaces.

3.05 PROTECTION

A. Protect work against damage until fully cured. Provide signs identifying wet surfaces until surfaces are adequately cured.

B. Touch-up of minor damage will be acceptable where result is not visibly different from surrounding themed surfaces.

3.06 SCHEDULE / COLORS

A. Refer to Character Reference Guide.

END OF SECTION

SECTION 104400

FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Portable fire extinguishers.

B. Fire extinguisher cabinets for portable fire extinguishers.

C. Accessories:
   1. Mounting brackets for wall mounted fire extinguishers.

1.02 RELATED SECTIONS

A. Section 061000 - Rough Carpentry: Wood blocking.

B. Section 092116 - Gypsum Board Assemblies: Wall substrate.

C. Section 099000 - Painting and Coating: Field paint finish.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. NFPA 10 - Standard for Portable Fire Extinguishers; National Fire Protection Association.

C. UL (FPED) - Fire Protection Equipment Directory; Underwriters Laboratories Inc.

D. Provide fire extinguishers approved, listed, and labeled by FMG.

1.04 SUBMITTALS

A. Fire Extinguishers and Cabinets: Include rating and classification.

B. Shop Drawings: Indicate cabinet physical dimensions and rough-in measurements for recessed cabinets.

C. Product Data: Provide extinguisher operational features, color and finish, anchorage details, and material descriptions.

D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.
   1. Provide for fire extinguishers and fire-protection cabinets to include in maintenance manuals.

1.05 COORDINATION

A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

1.06 FIELD CONDITIONS

A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Fire Extinguishers, Cabinets and Accessories:

1. JL Industries, Inc: www.jlindustries.com.
2. Larsen's Manufacturing Co: www.larsensmfg.com.
3. Kidde Fyrnetics
4. Potter-Roemer: www.potterroemer.com.
5. Substitutions: See Section 016000 - Product Requirements.

2.02 PORTABLE FIRE EXTINGUISHERS

A. Fire Extinguishers - General: Provide fire extinguishers of type, size and capacity for each fire-protection cabinet indicated which comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
   1. Provide extinguishers labeled by Underwriters Laboratories Inc. for the purpose specified and indicated.
   2. Instruction Labels: Include pictorial marking system complying with NFPA 10-1998, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance and recharging.

B. Multipurpose Dry Chemical Type Fire Extinguishers: Steel tank, with pressure gage.
   1. Class UL-rated 4-A:60-B-C.
      a. Provide Class K rated extinguishers at kitchen locations per local building codes.
   2. Size 10.
   3. Monoammonium phosphate-based dry chemical.
   4. Finish: Baked enamel, color as selected.
   5. Locations: As indicated on drawings but not less than required by local building codes.

2.03 FIRE EXTINGUISHER CABINETS

A. Metal: Formed stainless steel sheet, ASTM A 666 Type 304; 0.036 inch (0.9 mm) thick base metal.

B. Cabinet Type: Suitable for fire extinguisher.

C. Cabinet Construction: Provide non-rated unless installed in a fire rated wall. At fire rated walls, provide cabinet to maintain wall rating.

D. Cabinet Configuration: Recessed type: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
   1. Exposed Trim: Flat, one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend) of ¼" -5/16" (6-8mm).
   2. Trim: Returned to wall surface, with 1/4 inch (6 mm) projection, 1 1/2 inch (40 mm) wide face.

E. Cabinet Configuration: Semi-Recessed type: Cabinet box partially recessed in walls of shallow depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
   1. Square-Edge Trim: 1-1/4- to 1-1/2-inch (32- to 38-mm) backbend depth.

F. Cabinet Trim Material: Stainless-steel sheet.

G. Door: Stainless Steel sheet 0.036 inch thick, reinforced for flatness and rigidity; projecting lever handle with cam-action latch. Hinge doors for 180 degree opening with continuous piano hinge of same material and finish as trim.

H. Door Style: Vertical duo panel with frame.

I. Door Glazing: Glass, clear, 1/8 inch (3 mm) thick tempered break glass. Set in resilient channel gasket glazing.

J. Cabinet Mounting Hardware: Appropriate to cabinet. Pre-drill for anchors.

K. Weld, fill, and grind components smooth.

L. Accessories:
   1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-extinguisher cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
   3. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
   4. Door Lock: Cylinder lock, keyed alike to other cabinets.
   5. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
      a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
         1) Location: Applied to cabinet door.
         2) Application Process: Etched.
         3) Lettering Color: Red.
         4) Orientation: Horizontal.

M. Finish of Cabinet Exterior Trim and Door: Stainless Steel: No. 6 finish.

N. Finish of Cabinet Interior: White enamel.

2.04 ACCESSORIES

A. Extinguisher Brackets: Manufacturer's standard formed steel, galvanized and enamel finished, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated.
   1. Provide for locations of all fire extinguishers not mounted within cabinets. Refer to brackets listed above for fire extinguishers in cabinets.
   2. Color: Black.
   3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
      a. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
         1) Orientation: Horizontal.

2.05 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
   1. Weld joints and grind smooth.

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 (13 mm) thick.
   2. Miter and weld perimeter door frames

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.06 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. Finish fire-protection cabinets after assembly.

D. 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.

2.07 STAINLESS-STEEL FINISHES

A. General: Remove tool and die marks and stretch lines or blend into finish.
   1. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

B. Satin, Directional Polish: No. 6 finish.

C. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
   1. Examine walls and partitions for suitable framing depth and blocking where recessed and semi-recessed cabinets will be installed.

B. Verify rough openings for cabinet are correctly sized and located.

C. Examine fire extinguishers for proper charging and tagging.
   1. Remove and replace damaged, defective, or undercharged units.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Remove and replace damaged, defective, or undercharged units.

F. Secure rigidly in place.

3.02 PREPARATION

A. Prepare recesses for recessed and semi-recessed fire protection cabinets as required by type and size of cabinet and trim style.

3.03 INSTALLATION

A. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.
   1. Provide inside latch and lock for break-glass panels.

B. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
   a. Fire-Protection Cabinets: 54 inches (1372 mm) above finished floor to top of cabinet.
   b. Mounting Brackets: 54 inches (1372 mm) above finished floor to top of fire extinguisher.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

3.04 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 105100

LOCKERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Standard duty locker units with hinged doors.
   1. Metal Lockers

B. Bases, tops and filler panels to match lockers.

1.02 RELATED SECTIONS

A. Section 061000 - Rough Carpentry: Wood blocking and nailers.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.

C. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.04 SUBMITTALS

A. Product Data: Provide data on locker types, sizes and accessories.

B. Shop Drawings: Indicate locker plan layout, elevations, anchorage details and numbering plan.

C. Samples: Submit two samples 3 x 6 inches (75 x 150 mm) in size, of each color and material scheduled.

D. Manufacturer's Installation Instructions: Indicate component installation assembly.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver lockers until spaces to receive lockers are clean and dry.

B. Protect locker finish and adjacent surfaces from damage.

1.06 EXTRA MATERIALS

A. Replacement lock cylinders with keys equal to 10 percent of the lockers installed.

B. Key numbering kit: Mechanism for embossing plastic portion of key with locker number.

C. Two each, cash control and management keys.

D. Special tools required for replacing cylinders and other maintenance operations.

E. Accessible Key Holder: easy to grip, heavy-duty plastic, curved handle providing extra leverage for turning key.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Where noted, or adjacent existing lockers, the design intent is that lockers shall be manufactured and installed to match existing lockers in use at this location. Verify design, materials, dimensions, and hardware.

B. Steel Locker:

1. Design is based on: Best GoPod Lockers by Safemark, Tel: (800) 255-8818, www.safemark.com.

2.02 MATERIALS

A. Metal Locker:
   1. Cold rolled steel
   2. Color: As selected from manufacturer's full range of colors.
   3. Door hinge: Continuous piano hinge fabricated from 16 gauge type 304 stainless steel.

2.03 ACCESSORIES

A. Fillers: Provide finished trim to match lockers for closure and transition of lockers to adjacent surfaces at all corners and ends.

B. End Panels: Provide exposed ends of locker modules, and sloped tops, with finished panel to match lockers.

C. Mounting Hardware: Provide brackets, perforated ventilation strips, fasteners and other hardware of type and size recommended by manufacturers for type of substrate.

D. Interior Accessories for half tier and full tier lockers: Two double prong wall hooks, hat shelf.

E. Accessible Locker Identification: Identify accessible lockers with a decal. All accessible lockers to meet the requirements of the ADAAG and ICC/ANSI A117.1.

F. Netowkred kiosks and Intelligent Door keypads

2.04 LOCKER UNITS - TYPICAL

A. Unit Configurations: 5 Tier module, also refer to drawings.

B. Base: Metal base or plastic base to match lockers, unless noted otherwise in drawings.
   1. Base Height: 4 inch (100 mm).

2.05 FABRICATION - GENERAL

A. Factory-fabricate and fully assemble lockers; do not knock down for shipping.

B. Make lockers square with rigid joints, without dents or warped surfaces
   1. Door and frame fronts: No exposed bolts or rivet heads.
   2. Where exposed holes for built-in locks are not used, cover holes neatly using permanent materials.

C. Miscellaneous Components: Provide all parts, filler panels, closures, clips, and fasteners required for a complete installation.

D. Provide lockers in modules consisting of one or more tiers as determined by manufacturer for economy of fabrication and ease of shipping and installation.

2.06 FABRICATION - METAL LOCKERS

A. Exposed metal edges: Smooth off sharp edges and corners.

B. Exposed welds: Grind flush.

C. Doors: Fabricate with flanged edges, reinforced if required for stiffness, and designed to open and close without springing.
   1. Fabricate sheet steel doors of one piece.
   2. Provide extra stiffeners for doors more than 15 inches wide.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that prepared bases are in correct position and configuration.

B. Verify bases and embedded anchors are properly sized.

C. Verify that field measurements are as shown on the approved shop drawings.

D. Verify correct location of built-in framing and blocking.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install lockers plumb, and square tight between units.

C. Place and secure on prepared base.

D. Secure lockers with anchor devices to suit substrate materials. Minimum Pullout Force: 100 lb (445 N).

E. Bolt adjoining locker units together to provide rigid installation.

F. Install end panels, filler panels, and trim to completely close off openings.

G. Install accessories.

H. Test all movable components for smooth operation. Replace components that do not operate smoothly.

I. Installation to provide adequate ventilation.

3.03 CLEANING

A. Clean locker interiors and exterior surfaces.

B. Remove packaging and construction debris.

END OF SECTION

SECTION 108113

BIRD CONTROL DEVICES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Plastic needle strips

1.02 RELATED SECTIONS

A. Section 061000 - Rough Carpentry: Blocking for installations in this section.

B. Section 076100 - Sheet Metal Roofing: Substrate for installations in this section.

C. Section 076200 - Sheet Metal Flashing and Trim: Substrate for installations in this section.

D. Section 079200 - Joint Sealants: Sealant at perimeter of opening.

1.03 SUBMITTALS

A. Product Data: Manufacturer's descriptive product information, including installation instructions.

B. Verification Samples: Actual strips of specified models, not less than 6 inches (150 mm) long.

1.04 QUALITY ASSURANCE

A. Installers: Completely familiar with installation of products similar to those required for this project.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Acceptable Manufacturer: Bird-B-Gone, Inc; 15375 Barranca Parkway #D; Irvine, CA 92618; Tel: (800) 392-6915 or (949) 472-3122. Fax: (949) 472-3116.

B. Substitutions: See Section 016000 - Product Requirements.

2.02 BIRD CONTROL MATERIALS

A. Polycarbonate Needle Strips: Provide architectural bird control in the form of flexible needle strips made of clear polycarbonate for mounting over beams, parapet walls, etc.
   1. Width of coverage to be 5”-7” widths
   2. Height to be 4 ½”
   3. Base: Flexible
      a. Glue torugh on underside for ease of attachment woith adhesive
      b. Offset pre-drilled holes, for ease of attachment with screws and/or adhesive
   4. Length: 2’ sections
   5. Color: clear
   6. Material: U.V. stabilized polycarbonate Heat and weather resistant (+310F to -200F). Non-conductive and will not interfere with electronic transmissions.

B. Mounting System: Per manufacturers recommendation

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that installation surfaces are ready to receive architectural bird control. Do not proceed until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean installation surfaces thoroughly. Remove bird droppings and related bird refuse. Remove overhanging foliage.

3.03 INSTALLATION

A. Install architectural bird control in accordance with manufacturer's printed instructions.

B. Cover entire depth of surfaces indicated, cutting strips where necessary to fit strips to the installation surface properly. Make strips follow curves and contours closely.

C. Install at spacing specified in manufacturer's instructions, for uniform appearance and without end-to-end gaps.

D. Seal openings created by attachment in building finishes to prevent water intrusion.

E. Inspect finished installation and make adjustments as necessary.

END OF SECTION

SECTION 131420

THEME PROPS

PART 1 - GENERAL

1.01 SUMMARY

A. Theming Elements
   1. Props.

B. The scope of work is shown in the following documents:
   1. Drawings.
   2. Project Manual.
   3. Character Reference Guide.
   4. Exhibits and Graphics Guide.

1.02 SUBMITTALS

A. Submit the following to Owner and to Architect / Designer for approval:
   1. Samples of all replicated materials.
   2. Product data indicating that materials for use in this project are suitable for intended application. Include chemical composition, flame spread and fire rating.
   3. Finish stain and paint samples. This includes not only color brush-outs but also paint style for scenic painting areas.

B. Records of paint and stain mixing equations and any other pertinent information for use in making repairs and replacing parts in the future.

C. Substitute materials may be submitted, with the approval of the Architect/Designer, according to the substitutions procedures outlined in Section 016000. No material substitution shall be made without written approval by the Owner or Architect/Designer.

1.03 QUALITY ASSURANCE

A. Contractor Qualifications
   1. Contractor(s) must be experienced in producing projects similar in scope to that indicated for this project, with a record of successful in-service performance and sufficient production capacity to perform work required without causing delays in the work schedule.

B. The structural integrity, installation methods, workmanship, finishes, appearance and durability of each of the different elements in this project shall meet or exceed the highest established industry quality standards. Execution of any testing procedures required for this quality assurance shall be the responsibility of the contractor directly in charge of each of those elements. Test results shall be documented with actual materials and/or production samples.

C. Responsibilities
   1. Contractor shall supply any mounting supports needed. It shall be the responsibility of the Contractor to furnish and install all connections and accessories required to provide a complete installation. It is the responsibility of the Contractor to coordinate all structural requirements.
   2. The Contractor shall supply any required concrete footings. The Contractor shall provide templates and other needed coordination drawings to those doing the concrete work where fabricated items or their anchors are to be imbedded into concrete or masonry.

D. Conditions
   1. All items are to be installed in commercial, high-traffic areas.
   2. Elements are for year-round exterior or interior use in a climate with high humidity, extreme heat and sun exposure, and salt air with traces of chlorine.

3. Most elements will be within public reach and must be accordingly durable.

E. Fire Resistance
   1. All potentially combustible materials shall be fire-resistant. Whenever possible, fire resistance shall be inherent in the material. If necessary, applied fire retardants will be acceptable if they do not adversely affect the quality of the finished material. Documentation of flammability testing by qualified testing services shall be required for all potentially combustible materials. The degree of fire resistance for each material shall meet or exceed the requirements for a Class A fire-rating or other more stringent codes that are applicable in the jurisdiction of the project.

F. Warranty
   1. Products and workmanship for all components of the project shall be warranted for a minimum of five years from the date of final acceptance.
   2. Manufacturers and contractors shall provide copies of written statements of warranty to the Owner prior to final acceptance.

1.04 DELIVERY, STORAGE AND HANDLING

A. Inspect all buy-out material upon receipt from the manufacturer. Reject any defective or damaged materials and replace with new.

B. Handle and store all materials according to manufacturers' instructions.

C. Deliver elements to the project site in undamaged protective packaging labeled with specific contents.

D. Delay delivery of elements until footings and other required work is complete and the construction site is ready for final installation of the element(s) in question.

E. Protect materials from damage on construction site and store in safe, dry location.

F. Any material that becomes damaged during manufacturing, shipping or while being stored shall be replaced at no additional cost to the Owner.

1.05 PROJECT CONDITIONS

A. Take field measurements to fit work to actual construction. If it is not possible or practical to take field measurements before fabrication, provide adequate installation tolerances and trim to fit.

B. Coordinate installation of work with other project construction. Do not begin installation until potentially damaging conditions are corrected in the installation area.

PART 2 - PRODUCTS

2.01 METALS

A. General
   1. All exposed metal work shall free of seam marks, roller marks and/or trade names. Do not use materials that have stains or discoloration unless otherwise indicated.
   2. Metal cut-work shall have edges eased and polished, then finished to match face finish.
   3. All sharp edges and burrs shall be removed from all metal work.

B. Steel
   1. The strength and durability of all steel products shall meet or exceed the following standards:
   2. Plates, bars, angles, channels and H-sections: ASTM A36
   3. Tube
      a. Hot rolled: ASTM A 501
      b. Cold rolled: ASTM A 500
   4. Pipe: ASTM A 53

5. Finish: Hot-dip galvanizing after fabrication in accordance with ASTM A 123 at 1.25 ounces per square foot for surface area unless otherwise specified.

C. Aluminum: The strength and durability of all aluminum products shall meet or exceed the following standards:
   1. Plate and sheet: Alloy 6063-T5 meeting ASTM 209
   2. Extrusions: Alloy 6063-T5 meeting ASTM 221
   3. Finish: Painted finish shall be as noted in Color Manual.
   4. Properly prepare to bind to the prime and paint surface.
   5. Provide gaskets, insulation or other methods necessary to prevent galvanic corrosion between dissimilar metals.

2.02 FASTENERS

A. General
   1. All mechanical fasteners shall be concealed unless indicated otherwise as part of a thematic design look. They shall be corrosion-proof and chemically compatible with all adjacent materials.
   2. Any screw, bolt head or other mechanical fastener that cannot be concealed shall be countersunk and colored to match the surrounding area, whenever possible.

B. Anchors and Inserts
   1. Use stainless steel or aluminum anchors and inserts for exterior installations and elsewhere as required for corrosion resistance.

C. Attachment Hardware
   1. Use stainless steel or aluminum unless otherwise noted.

D. Hanging Cable
   1. Use stainless steel of the smallest diameter required to hold the weight load safely.

2.03 FIBER REINFORCED PLASTIC (FRP) FIBERGLASS

A. Fiber Reinforced Plastic (FRP) shall be manufactured and installed to meet or exceed the highest professional standards for appearance, quality and durability.

B. FRP shall consist of glass fiber reinforced polyester material with a high strength-to-weight ratio achieved by thermal-setting polyester resins, reinforced with chopped glass fiber strands. A molded-in layer of gel coat shall be used to seal the resin and glass laminates against pinholes and fiber bloom (transfer pattern of the glass strands to the molded surface.) The gel coat shall thus serve as an undercoat for the final finishes. Multiple layers of protective finish coatings such as polyurethane with ultraviolet inhibitors shall be applied and shall be matte, satin or glossy, depending upon the effect required in the design and shall be formulated with components that resist yellowing and chalking. Inorganic pigments shall be used to assure color stability and to minimize fading. Whenever possible, colors shall be subsurface and integral with the molded, gel coated FRP forms.

C. FRP surfaces shall be smooth, free of dimples, scratches, gouges, air bubbles, bulges, foreign matter or any other imperfections unless such irregularities have been specified by the Architect / Designer as part of a textured finish. Any accidental “dimpling” or gouges caused by improperly fabricated molds are unacceptable.

2.04 PAINT

A. Quality
   1. Coloring agents used in this project shall be as stable as possible. Any fading, discoloration or de-lamination within the warranty periods shall be unacceptable

2. Paints, pigments, inks, resins and other materials shall be compatible with adjacent materials and guaranteed not to cause deterioration or de-lamination of any materials used in fabrication.
3. No paint or pigment shall have lead content
4. Unless stated otherwise, use satin finishes.

B. Manufacturers
1. Basis of Design: Matthews Paint Company, a division of PPG Industries, Delaware, OH, 800-323-6593, www.ppg.com/coatings/matthewspaint
    a. Sherwin Williams, www.sherwinwilliams.com
    b. Rosco Laboratories; www.rosco.com
    c. Substitutions: Refer to Section 016000 for substitution procedures.
1. Provide the Manufacturer's premium grade product, top-coat and primer, complying with compositional requirements and recommended for anticipated exposures and substrates.
2. For each individual system, provide primer and other undercoat paint produced by the same manufacturer as finish coat.
3. Sign Paints: Color to match Pantone colors in Matthews Acrylic Polyurethane - satin finish.

C. Top-coat colors and textures as indicated on Drawings.

2.05 WOOD

A. Not allowed.

2.06 WINDSOCK

A. Product: Rainbow 96" Spinsock, World of Windsocks, 206-457-3472, www.worldofwindsocks.com
1. Quantity: One (1).
2. Accessories:
    a. Multiple heavy-duty swivels for hanging.
    b. Windsock Mounting Pole, 4' fiberglass pole with swivel arm and mounting brackets.

B. Installation: Securely attach 4' fiberglass windsock mounting pole with swivel arm and mounting bracket to building structure with tamper proof hardware.

PART 3 - EXECUTION

3.01 FABRICATION

A. Components shall be shop-fabricated and shop-assembled as much as possible.

B. Responsibility for methods and techniques used to construct the work lies with the Contractor. Construction methods shall be employed that ensure that the final product is structurally sound and, in the case of exterior elements, weather-resistant.

C. Fabricate or purchase in the sizes and shapes as indicated on Drawings.

3.02 METAL

A. Fabricate and shop-assemble in largest sections practical for delivery to site.

B. Prepare and/or reinforce fabrications as necessary to receive applied items

C. Fabricate items with joints tightly fitted and secured. Make exposed joints tight, flush and hairline.

D. Grind all exposed edges. Give all corners a radius of 1/8-inch unless otherwise noted in drawings.

E. Welding
1. All welding must be accomplished so that permanent distortions of flat surfaces are minimized.
2. Provide continuous welds at welded corners and seams.

3. Remove all welding flux and oxides by grinding or pickling so that these areas match the finish of adjoining areas.
4. Any damage caused by fabrication shall be repaired by grinding, polishing or buffing.

F. Provide gaskets, insulation, or other method necessary to prevent galvanic corrosion between dissimilar materials.

G. Do not cut or weld items galvanized after fabrication that are indicated for bolted or screwed connections.

H. Repair any damage to galvanized surfaces using galvanizing repair paint in accordance with ASTM A780.

3.03 FIBERGLASS

A. Replicated materials are to appear authentic, as judged by Architect / Designer.

3.04 INSTALLATION

A. Site Examination
1. Verify that footings, blocking and backings have been installed in the appropriate locations for anchoring.
2. Examine substrates and finishes of areas to receive elements and determine if they are in satisfactory condition for installation. Do not proceed with installation of elements until unsatisfactory conditions have been corrected.
3. Do not install work until potentially damaging construction operations in the installation areas are completed.

B. Location
1. Comply with location information on contract drawings except where project conditions require adjustment of said locations.
2. Notify Architect / Designer of any significant deviations from specified locations.

C. Attachment
1. All elements are to be securely and permanently attached at locations shown unless otherwise indicated.
2. Conceal all fasteners. Where concealment is not possible, countersink hardware and fill.
3. Cut work precisely to fit. Treat cuts in the field as specified in the Fabrication section.
4. Use epoxy or other permanent adhesive for attachment only when other means are not possible.

3.05 ADJUST AND CLEAN

A. Remove packing material from elements and leave units in clean condition, ready for use.

B. Repair or remove and replace defective work as directed upon completion of installation.

C. After installation, clean all exposed surfaces, touch-up as required, and remove or refinish damaged or soiled areas.

3.06 PROTECTION

A. Contractor to provide procedures and precautions for protection of materials and installed elements from damage by work of other trades.

B. Protect elements against damage during remainder of construction period.

C. Remove all temporary protection when the work is ready to be turned over to the Owner.

3.07 INSTRUCTION

A. Before leaving site, instruct designated Owner personnel in the operation and maintenance of all elements.

B. Provide Owner with maintenance information for all elements.

END OF SECTION

SECTION 131433

RIDE ACTUATING GATES

PART 1 - GENERAL

1.01SECTION INCLUDES

A. Actuated swinging gate assemblies.

B. Work includes the design, furnishing, and fabrication of actuated gates and associated pneumatic actuators, mechanical components, and control equipment.

C. Delegated design.

D. Spare parts.

E. Actuating Gate Manufacturer / Vendor shall provide actuated gates.

F. General Contractor shall coordinate installation of actuated gates.

G. Ride Manufacturer shall provide and General Contractor shall install an Uninterruptible Power Supply (UPS) for the Ride Control System.

1.02 RELATED SECTIONS

A. Section 010310 Alternates.

B. Section 033000 Cast-in-Place Concrete: Concrete Connections.

C. Section 055000 Metal Fabrications: Miscellaneous attachments.

D. Section 099000 Painting and Coating: Primer and finish coats.

E. Division 23 - Mechanical: Compressed Air Systems.

F. Division 26 - Electrical: Conduit and Wiring.

1.03 DEFINITIONS

A. Station Gate: A mechanism that prevents patrons from entering in to areas that are not intended for public occupancy during normal operation. A gate that keeps patrons in the Station Area while loading on to and off of a ride vehicle. Station Gates are typically located at the ends of vehicle parking positions to keep guests from getting in front or behind a ride vehicle.

B. Load Gates: A mechanism that prevents patrons from approaching a ride vehicle. “Load Gates” include both Load and Unload Gates. A gate that opens to allow patrons to load on to or off of a ride vehicle. Load Gates are typically aligned with rows and seats of the ride vehicle to guide patrons on and off a ride vehicle.

C. Actuating Gates: A term to include all gate types as required by the application.

D. Ride Clearance Envelope: Envelope determined by the Ride Manufacturer that needs to be clear for the ride to be in motion. This envelope includes clearance for equipment and the patron reach envelope.
   1. Additional Reference: ASTM F2291 Section 3.1.21 *patron clearance envelope*.

1.04 QUALITY ASSURANCE

A. Perform, design and prepare shop drawings under direct supervision of a professional structural engineer experienced in design of this work.
   1. Calculations required for structural design shall meet the requirements of the project's jurisdiction.

B. Manufacturer Qualifications: A firm experienced in producing actuating gates 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. Professional Engineer Qualifications: Design members and connections under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed by the authority having jurisdiction.

D. Installer Qualifications: Company specializing in performing the type of work specified in this section with minimum five years of experience.

E. Codes and Standards:
   1. Comply with applicable Local, State and Federal building codes, as identified in Division 01.
   2. Comply with the following standards in effect as of the date of the Contract Documents, except where more stringent requirements are specified or required.
   3. American Society for Testing and Materials (ASTM):
      a. A570 Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
      b. F24 F2291 Standard Practice for Design of Amusement Rides and Devices, F24 1193 Standard Practice for Device Manufacturer Quality Assurance Program and Manufacturing Requirements
   4. American Welding Society (AWS): Welding Sheet Steel in Structures.
      a. Welding shall be performed only by qualified operators using proper equipment for the type of work required.

1.05 DESIGN REQUIREMENTS

A. Actuating Gate Manufacturer / Vendor shall assure the gate motion envelope is either clear of the Ride Clearance Envelope at all times, or the motion of the gates are coordinated with the ride control system to assure the ride equipment is not moving while the gates are within the Ride Clearance Envelope.

B. Actuating Gate Manufacturer / Vendor shall provide all site and utility requirements to Owner, including all pneumatic, electrical and mechanical requirements, sizes and locations of enclosures, and all structural requirements including load reactions due to the movement of the gates and fastening details.

C. Actuating Gate Manufacturer / Vendor shall review architectural, electrical, mechanical and plumbing drawings to gain general understanding of the limitations imposed by the building infrastructure. Actuating Gate Manufacturer / Vendor shall notify the Owner of any new requirements that must be added to the building infrastructure to provide Actuating Gates that meet the requirements of this specification.

D. Gate assembly shall meet an Interior Finish Classification of Class A (e.g. be made of non-combustible material) as defined by the governing building code.

E. Performance Requirements:
   1. Operating hours (average) = 2 cycles per minute, 12 hours, 365 days per year or as otherwise identified by the Owner.
   2. Gate actuation mechanism shall be pneumatic.
   3. In the event of electrical power failure:
      a. The gates shall not start to move.
      b. If the gates are in motion, the gate shall not reverse direction and shall move to the final open or closed position.
      c. If the gates are closed, the gate shall remain locked or secured (unless commanded to open by the Operator) to withstand the required force per ASTM 2291.
   4. Actuating Gate Manufacturer / Vendor shall provide sufficient accumulated air to cycle the gates through their full range of motion twice. One cycle is a move from the fully closed

(retracted) position to the fully open (extended) position and back to the fully closed (retracted) position.

5. Gates shall remain closed if a maximum force as specified by ASTM 2291 is applied to the outer edge of the actuated gate.
    a. For gates directing patrons to a ride vehicle, gate motion shall limit the force as specified by ASTM 2291 on an object that is pinched between the gate and the fixed closed or open position, or between two swinging elements (e.g. “leaves”) of a gate for a single patron line.
6. Gates shall complete their range of motion (open or close) in less than three (3) seconds, starting with the command to move from the Ride Control System and ending with reaching the final position.

F. Safety Requirements:
    1. Actuating Gate Manufacturer / Vendor shall conduct a Risk Assessment per ISO 13849-1 to determine the appropriate performance levels required by the control system. The scope of the Risk Assessment shall be from the when the Operator is standing at their ride console with the Load Gates closed to when the patron is completely boarded on to the ride vehicle. The Risk Assessment shall consider the following:
        a. Hazard of Ride Clearance Envelope violations.
        b. Hazard of access to open track areas.
        c. Station geometry.
        d. Operator’s reaction time and responsibilities.
        e. Spaces which Operators and patrons could occupy in the Station area.
    2. Actuating Gate Manufacturer / Vendor shall define safety-related control system functions with appropriate performance levels for the gate system. Examples of safety-related control system functions include, without limitation:
        a. The Ride Vehicle shall be permitted to move in the Station Area if the Station Gates are extended and the Load Gates are retracted.
        b. The Load Gates shall be permitted to open if the Station Gates are retracted
        c. The Station Gates shall be permitted to extend if the Load Gates are closed and locked.
    3. Actuating Gate Manufacturer / Vendor, in coordination with the Owner and the Ride Manufacturer, shall define all fault detection for maintaining the defined safety requirements. Examples of fault detection include, without limitation:
        a. Position sensor failed software alarm that disables gate from normal operation.
        b. Loss of air pressure in pneumatic system.
        c. Delay in swing motion, as determined by the Actuating Gate Manufacturer / Vendor’s failure modes and effects analysis.
    4. Intrinsically safe design measures, for example, friendly surfaces, safe distance, low pressures for gate movement, and removal of structures from clearance envelopes, may be used to influence performance levels of safety functions.

G. Thematic Elements:
    1. If provided, thematic items to be attached to the gates shall be sent to the Actuating Gate Manufacturer / Vendor to be pre-attached and tested, unless otherwise coordinated by the Owner, General Contractor or Theming Contractor.
    2. Actuating Gate Manufacturer / Vendor to coordinate the following items with the Theming Contractor.
        a. Weight limitations of thematic elements.
        b. Attachment locations.
        c. Structural bracing of thematic elements.
        d. Delivery schedule.

1.06 INFORMATIONAL SUBMITTALS

A. Safety Analysis to identify safety functions for the Actuating Gates are what hardware has been provided to mitigate hazards that related to the failure modes of the mechanisms and control systems provided by the Actuating Gate Manufacturer / Vendor.

1.07 SUBMITTALS

A. Delegated-Design Submittal: Include structural analysis data for fabrications to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation and licensed by the authority having jurisdiction.

B. Shop drawings: Indicate dimensions, component sizes, fabrication details, attachment provisions, finishes, and coordination requirements with adjacent work.
   1. Indicate gate layout and clearance envelope of gate in context of the building identifying all adjacent building elements.
   2. Indicate relationship to Ride Clearance Envelope and patron clearance envelope both in section and plan for the open and closed positions of each gate.
   3. Indicate attachment points and details of attachment of all thematic elements.
   4. Provide layout and attachment details of structural supports and include load calculations of each point of attachment to the building structure.

C. Piping Schematics.
   1. Provide plans showing the routing of air piping within each gate unit up to the point of connection of the facility-provided ball valve.
   2. Identify all valves, regulators and associated equipment requiring access by maintenance.
   3. Provide diagram indicating locations of connections for air piping to building compressed air system; identify type and size of fittings.

D. Control Schematic
   1. Provide electrical schematics showing wiring of control/electrical components.
   2. Provide dimensional layout of control sensors and product data of each type of sensor used.
   3. Provide written Sequence of Operation and control logic descriptions of each sensor function.
      a. Actuating Gate Manufacturer / Vendor shall make any necessary changes to the theory of operation following review by the Ride Manufacturer and the Owner.
      b. Sequence of Operation shall include all failure mode detection logic and required diagnostics as defined by the Safety Requirements.

E. Product Data:
   1. Provide product data binder - collection of cut sheets for all hardware or equipment, devices provided.

F. Maintenance Data:
   1. For each type of gate submit operating and maintenance instructions and manuals, parts inventory list and a schedule of preventive maintenance.

1.08 SPARE PARTS

A. Each gate shall include the recommended spare parts for the first year of operation.
   1. The cost for the first year of spare parts shall be included with the Actuating Gate Manufacturer / Vendor's scope of work.

B. Recommended Spare Parts:
   1. Actuating Gate Manufacturer / Vendor shall submit an itemized list of recommended spare parts. The list shall identify quantity, replacement schedule, and estimated cost of each recommended item. Include the source for purchasing of each item.

1.09 SHOP TESTING

A. Shop Testing:

1. Owner may waive or modify Shop Testing requirements, in writing, provided the Actuating Gate Manufacturer / Vendor is able to demonstrate the gate design is service proven and has been successfully implemented in other ride applications.
2. Gates are to be fully assembled and cycled in the Actuating Gate Manufacturer / Vendor's shop.
3. Testing to include all attached thematic items, if available from Theming Contractor.
4. Each gate type is to be cycled 2,500 complete cycles.
5. Each duplicate gate type is to be cycled 250 complete cycles.
6. An Owner's representative and representative from the General Contractor shall have the option to observe the shop testing.

B. Final Field Testing:
1. Actuating Gate Manufacturer / Vendor's representative shall participate in field-testing involving testing of the other show assemblies like ride, special effects, etc. for minimum 1 week.

1.10 PRE-INSTALLATION MEETING

A. A minimum of 30 days prior to start of work, the Actuating Gate Manufacturer / Vendor shall convene a pre-installation meeting for the purposes of fully coordinating all aspects of the Work.
1. Meeting attendees shall include representatives of the Owner, General Contractor, and all subcontractors having work in or around the Actuating Gate equipment.

B. As a minimum, the following shall be covered in the pre-installation meeting:
1. Installation schedule and procedures.
2. Inspection of utility rough-in and dimensional location verification, including framing.
3. Structural attachment points and details.
4. Review pneumatic and electronic systems.
5. Review of control components and theory of operation of gates.

1.11DELIVERY, STORAGE AND HANDLING

A. Actuating Gate Manufacturer / Vendor shall coordinate availability of on-site storage for gate components. If no storage area for gate components is available at Owner's property then Actuating Gate Manufacturer / Vendor shall store the gate components and not deliver components until the Actuating Gate site area is ready for installation. Components shall be stored indoors prior to installation.

B. Package materials to prevent damage to components and thematic elements during shipment.

C. Provide protective coverings to prevent physical damage or staining following installation for duration of project.

1.12 WARRANTY

A. Actuating Gate Manufacturer / Vendor shall confirm in writing, that the material to be furnished will be free of defects in materials and workmanship for a period of one (1) year from the date Substantial Completion.

B. Actuating Gate system shall be warranted for a period of one (1) year after the date of Substantial Completion. Warranty shall include proper functioning of the system for the specified period.

PART 2 - PRODUCTS

2.01 APPROVED ACTUATING GATE MANUFACTURERS / VENDORS

A. Refer to Owner Provided documentation for manufacturer, model, and details.

B. Substitutions: See Section 016000 - Product Requirements.

2.02 MATERIALS

A. Gates and railings shall be ASTM A276 Type 304
   1. Gates and rails shall be smooth and free of surface rust, scale, grease, and foreign matter.

2.03 PNEUMATIC SYSTEMS

A. Pneumatic hardware and equipment required to control the gates shall be provided as indicated herein.
   1. General Contractor shall provide air compressor, piping from the air compressor to the main cabinet and piping from the main cabinet to any auxiliary enclosures. Ball valves will be provided at each end of this piping for location isolation.
   2. Actuating Gate Manufacturer / Vendor shall provide all components within the main cabinet as well as the main cabinet itself, all components within auxiliary enclosures including the enclosures themselves, as well as all piping required for final connections from auxiliary enclosures to gate actuators.

B. Interface to the Actuating Gate system shall be a point of connection ball valve provided by the General Contractor.

C. Actuating Gate Manufacturer / Vendor shall specify all pneumatic requirements to be provided by the General Contractor. The following requirements apply to the pneumatic elements specified by the Actuating Gate Manufacturer / Vendor and provided by the General Contractor. Any deviation from these requirements must be approved by the Owner in writing.
   1. Hard pipes to be type L copper.
   2. Flexible hoses to be Therm-O-Blue (200 psi rated) manufactured by Swan Inc. or FESTO.
   3. Facility air shall be clean, dry and supplied at 100 psi.

D. Actuating Gate Manufacturer / Vendor shall provide pneumatic accumulators as required to move the gate in the event of power loss.
   1. The local accumulator shall be sized to move the gate at least two complete cycles (open, close, open, close) upon loss of pneumatic power.

E. All valves, regulators and equipment are to be located in a main enclosed cabinet, rated for the anticipated environment, located near the main control cabinet, in a location approved by Owner, and easily accessible by maintenance personnel.

F. Pneumatic Control Cabinet Configuration: Provide the following configuration, unless otherwise requested by the Actuating Gate Manufacturer / Vendor and approved by the Owner in writing:
   1. The pneumatic cabinet shall be wall-mounted and occupy a space with a maximum size of 50”H x 50”W x 12”D.
   2. The main control cabinet shall be on the right-hand side of the pneumatic cabinet and all wiring will enter the cabinet at the bottom right-hand corner.
   3. A single 30A 120V power input from the facility will be provided at the top right-hand corner of the cabinet.
   4. A single network connection from the Ride Control System will be provided at the top left-hand corner of the cabinet.
   5. Control wiring for pneumatic valves shall leave the cabinet at the bottom left-hand corner of the cabinet.
   6. Control wiring for sensors shall leave the cabinet at the bottom right-hand corner of the cabinet.
   7. A single pneumatic input from the facility will provided at the bottom left-hand corner of the cabinet.
   8. There shall be three pipes leaving the cabinet per vehicle parking position, one for Station Gates; one for Load Gates (Unload Side), and one for Load Gates (Load Side), or other arrangement as specified by the Owner.

G. Auxiliary pneumatic enclosures proximate to the gates for pneumatic distribution shall be provided by the Actuating Gate Manufacturer / Vendor.
   1. There shall be four enclosures per vehicle parking position: Load Gates (Unload Side), Station Gates (Unload Side), Load Gates (Load Side) and Station Gates (Load Side) for a station with two load and unload vehicle parking positions.

H. Auxiliary pneumatic enclosures are provided by Owner's Contractor and installed by General Contractor. Refer to Owner Provided documentation for details.

I. Input for each enclosure shall be a maximum of 100 psi.

2.04 ELECTRONIC AND CONTROL SYSTEMS

A. Electrical and control hardware required to control the gate shall be provided as indicated herein.
   1. General Contractor shall provide (1) 120V, 30A circuit to the main cabinet, (1) Cat6 Ethernet connection from the Ride Control System to the main cabinet, as well as (1) 3/4" empty conduit to accommodate 5 x 18 AWG (for air cylinder sensor) and 3 x 18 AWG (for solenoid valve) from the main cabinet location to each of the auxiliary enclosures.
   2. Actuating Gate Manufacturer / Vendor shall provide all components within the main cabinet as well as the main cabinet itself, all components with auxiliary enclosures including the enclosures themselves as well as all conduit and wring required for final connections from auxiliary enclosures to gate actuators.

B. Actuating Gate Manufacturer / Vendor shall provide gate power supplies including UPS, pneumatic valves, sensors and an Input-Output (I/O) system that meets the safety and control requirements of the Ride Control System (RCS.)
   1. I/O components shall be networked to the Ride Manufacturer's RCS and shall use the same I/O hardware and network technology selected by the Ride Manufacturer.

C. Actuating Gate Manufacturer / Vendor shall include pressure switches to detect a loss of air pressure from the facility system. This pressure switch shall be integrated in to the I/O system provided by the Actuating Gate Manufacturer / Vendor.

D. Ride Manufacturer shall include an Uninterruptible Power Supply (UPS) for the Ride Control System capable of maintaining power to all electronics for twenty (20) minutes and powering the valve system to support cycling the gates at least three full cycles (one cycle is open and close.)

E. The Actuating Gate I/O system shall include provisions for adding (at a later date) four (4) dual-channel outputs, four (4) dual-channel inputs and a PLC of the same type as the Ride Control System. These provisions include network ports, power, terminals and enclosure space.

F. Unless otherwise specified by the Actuating Gate Manufacturer / Vendor and approved by the Owner in writing, the Operator Controls provided by the Ride Manufacturer shall include:
   1. Gate open and close spring-return-to-center switch located at the platform. There will be one operator control for each side (Load and Unload) for each vehicle position.
   2. Station Gate over-ride switches are internal to Ride Manufacturer's control panel. Refer to Owner Provided documentation for details.

G. Operator controls will be provided by the Ride Manufacturer and connected directly to the Actuating Gate Manufacturer / Vendor I/O system.
   1. All electronics shall be in a main enclosed cabinet, rated for the anticipated environment, located near the main pneumatic cabinet, in a location approved by the Owner and easily accessible by maintenance personnel, unless otherwise requested by the Vendor and approved by the Owner in writing.

H. Electronic Control Cabinet Configuration: Provide the following configuration, unless otherwise requested by the Actuating Gate Manufacturer / Vendor and approved by the Owner in writing.
   1. The control cabinet shall be wall-mounted and occupy a space with a maximum size of 50"H x 50"W x 12"D.

2. A single 30A 120V input from the facility will provided at the top right-hand corner of the cabinet.
3. A single network connection from the Ride Control System will be provided at the top left-hand corner of the cabinet.
4. Control wiring for pneumatic valves shall leave the cabinet at the bottom left-hand corner of the cabinet.
5. Control wiring for sensors shall leave the cabinet at the bottom right-hand corner of the cabinet.

I. Ride Control System will be responsible for the following:
   1. Operator push-buttons or switches
   2. Control software to execute the following:
      a. Opening and closing the Load Gates.
      b. Locking of the Load Gates.
      c. Extending and retracting the Station Gates.
      d. Interlocking of gates and vehicles such that Load Gates are not commanded to open and Station Gates are not commanded to retract if a vehicle is not parked in front of the gate.
      e. Interlocking of gates and vehicles such that vehicles do not leave a load or unload position if a Station Gate is not extended and Load Gate is not closed and locked.
      f. Monitoring of gate position as required.
      g. Indications of gate status to Operator.
      h. Reporting of alarm messages.
   3. Actuating Gate System will be responsible for the following:
      a. Movement of the gates.
      b. Locking of the gates.
      c. Sensing closed position of the gates (controls by Ride Manufacturer.)
      d. Networked I/O system connected to Ride Manufacturer's RCS.

2.05 FABRICATION

A. Gate assembly shall be self-supporting and shall not attach to the building structure except at the floor slab and the roof structure, unless otherwise approved by the Owner in writing.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine gate areas, with Owner's Project Manager and General Contractor present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which actuating gates work is to be installed.

B. Prepare written report listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Alignment: Actuating Gate components shall be installed plumb and level, accurately fitted, free from distortion or defects.

B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. After erection, installer shall prime welds, abrasions, and surfaces not shop finished, except surfaces to be in contact with concrete.

D. Maintain or restore stainless steel finish after welding or other process that removes the finish during fabrication.

E. Conduit and wire, including terminations, shall be installed per Division 26 specifications.

3.03 FIELD QUALITY CONTROL

A. Actuating Gate Manufacturer / Vendor shall make final operating adjustments including checking all hardware and equipment for proper operation, making any required adjustments to fine tune assemblies, and performing cycle testing of door operation prior to any ride testing.

B. Actuating Gate Manufacturer / Vendor is responsible for proper functioning of all sensors and control devices that integrate with the Ride Control System. This includes coordinating with the Ride Manufacturer to verify the proper operation of the gates per this specification.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to instruct Owner's maintenance personnel to operate, adjust, and maintain actuating gates.

B. Check operation of actuating gates with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

3.05 PROTECTION

A. Provide protective coverings to prevent physical damage or staining following installation.

B. Protect installed components from damage until Substantial Completion.

END OF SECTION

2021 Attraction
San Diego, CA

Issue for Bid
PROJECT MANUAL
VOLUME 2 OF 2: DIV. 21-41
PGAV Project Number: 64096-00
Issue Date: March 5, 2020

Sea World LLC
d/b/a SeaWorld San Diego

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Structural Engineers:
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MEP/FP Engineers:
Exp, Inc.
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SEAWORLD SAN DIEGO
SWSD 2021 ATTRACTION

ISSUE FOR BID

MARCH 5, 2020

THE COMPLETE LISTING OF CONTRACT DOCUMENTS IS TO BE PROVIDED BY THE OWNER

PROJECT MANUAL:

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS DOCUMENTS ARE PROVIDED BY THE OWNER

VOLUME 1

DIVISION 11 – EQUIPMENT

NOT USED

DIVISION 12 – FURNISHINGS

NOT USED

DIVISION 13 – SPECIAL CONSTRUCTION

131420 THEME PROPS
131433 RIDE ACTUATING GATES

DIVISION 14 – CONVEYING EQUIPMENT

NOT USED

VOLUME 2

END OF TABLE OF CONTENTS

SECTION 210500

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Grout.
   3. Access panels
   4. Fire-suppression demolition.
   5. Painting
   6. Supports and anchorages.
   7. Commissioning

1.03 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.

1.04 SCOPE

A. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work may not be specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

B. It is the intent that these Specifications and associated Drawings establish minimum requirements for products and equipment with the intent to provide fire protection systems finished, tested and ready for operation. Incidental detail that is not shown or specified, but necessary for proper installation and operation shall be included in the work and in these Contractor's estimates, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each pipe and piece of equipment to minimize conflicts with other trades.

C. Information and components shown on riser diagrams but not shown on plans, and vice versa, shall be provided as if expressly required on both.

D. It is the requirement of these Contract Documents to have the contractors provide systems and components that are fully complete, operational and suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the Contractor has failed to notify the Architect of the situation the Contractor shall include the specific components or subsystems with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

1.05 MODIFICATIONS IN LAYOUT

A. Drawings are intended to outline the scope of work required and are not intended to be installation drawings. Drawings are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component nor do they show the exact routing and locations needed to coordinate with structure and other trades and to meet Architectural requirements. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

B. Unless specifically stated to the contrary, no measurement of a drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

C. Prior to installation of visible material and equipment (including access panels) in finished spaces, review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

D. Check Contract Documents, as well as, Submittals and Shop Drawings of all subcontractors to verify and coordinate spaces in which work of Divisions 21 through 28 will be installed.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades. Systems shall be run parallel with or perpendicular to major architectural and structural building elements.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.06 SUBMITTALS

A. Welding certificates.

1.07 COORDINATION

A. Coordinate arrangement, mounting, and support of piping and equipment:
   1. To maintain maximum headroom; all piping, duct, conduit and associated components to be as tight as possible to underside of structure to provide for ease of disconnecting the equipment with minimum interference to other installations.
   2. To allow right of way for piping installed at required slope.
   3. To 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."

1.08 COORDINATION DRAWINGS

A. When included as part of the Contract Documents, there shall be full cooperation and coordination of all specialty trades.

B. This Division's contractors shall comply fully with the requirements set forth in the Division 23 "Coordination Drawings" specification section.

1.09 RECORD DOCUMENTS

A. Record Drawings are specified in Division 01 Section "Project Record Documents."

B. The Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing each pipe, valve, and piece of equipment. Record documents are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner in both electronic and hard paper copy formats. Record drawings shall also include:
   1. Locations of buried piping or similar items. Include buried depth.
   2. Field changes of dimension or detail.
   3. Changes made by field order or change order.
   4. Details not on original contract drawings.

1.10 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in a coordinated manual. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.
   1. Copies of all approved submittals/shop drawings.
   2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.
   3. Startup and shutdown procedures.
   4. Flow diagrams.
   5. Test records.
   6. Wiring diagrams.
   7. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment.
   8. Owner's written acknowledgement of satisfactory completion of instruction period.

C. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

D. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions.

E. Multiple Re-submittals: The Engineer will review the first submittal from the contractor and respond with comments, and will review one re-submittal for the same item(s) from the contractor and respond with comments. If the contractor is required to make subsequent submittals for the same item(s) the Engineer shall be compensated by the contractor for the time to review each

subsequent re-submittal. The contractor shall agree to compensate the Engineer a minimum of $500 per each re-submittal item.

F. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly.

G. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.

H. Shop drawings for different systems and equipment shall be bound separately by specification section as indicated above and not bound by manufacturer. Each separate submittal shall have its own transmittal and cover letter. Submittals which contain different specification section systems bound together may be returned un-reviewed for re-submittal.

1.11 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 Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. The work performed under this Division shall be performed by a State of [**Florida**][**Other**] certified fire protection contractor with a minimum of 5 years of experience.

E. Acceptable Manufacturers
   1. The Engineer’s design for each product is based on the manufacturer listed in the schedule or shown on the drawings. In Part 2 of some technical specifications, other manufacturers are listed as being acceptable. The listing of a manufacturer as acceptable does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. These are acceptable only if, as a minimum, they:
      a. Meet all performance criteria listed in the schedules and outlined in the specification.
      b. Have identical operating characteristics to those called for in the specification. For example, a two-stroke diesel generator will not be acceptable if a four-stroke model is specified.
      c. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer’s name appears as acceptable shall not be taken to mean that the Engineer has determined that the manufacturer’s products will fit within the available space - this determination is solely the responsibility of the contractor.
      d. Products must adhere to all architectural considerations including but not limited to: being of the same color as the product scheduled or specified, fitting within architectural

enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.

e. All equipment shall be labeled or listed by the National Board of Underwriters Laboratories (U.L.) where such labeling or listing exists for such material.

1.12 TEMPORARY SERVICES/CONTINUITY OF UTILITY SERVICES

A. In the absence of specific requirements in Division 1, comply with the following procedures for shut-downs.

B. Provide temporary services where project construction schedule requires extended shut downs of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shut downs are interruptions of existing services for a period of time longer than that acceptable to the Owner.

C. Contractor shall coordinate any shutdowns of existing systems as follows:
   1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.
   2. Minimize timeline of shutdowns of any system.
   3. Provide temporary services where required and perform shutdowns and tie-ins at a time convenient to Owner.
   4. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
   5. Perform required survey and inspection work required by the notice for shutdown.
   6. All life safety systems shall be returned to service at the end of each work day, when work is being performed on the systems. It is the responsibility of the Contractor to provide all associated appurtenances necessary to ensure that the systems are in proper working condition at all times.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment/materials from damage during shipping, storage, handling and installation. Delivery equipment/materials to the site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building “dry-in”, to prevent any damage resulting from inclement weather or construction traffic. Specialties shall not be stored outdoors.

1.14 PERFORMANCE REQUIREMENTS

A. Seismic Performance: All piping and support and installation shall withstand effects of earthquake motions determined according to NFPA 13.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection. This is applicable for all Division 21 sections.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12.

G. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

2.04 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.05 CEILING ACCESS AND ACCESS PANELS

A. Access panels are generally not shown on the drawings, but they are required to be provided by Contractor.

B. Furnish access panels for installation under other Sections valves or other items installed under this Division require access and are concealed in floor, wall, furred space or above ceiling. Access panels shall be by Milcor, Knapp, Nystorm or Inland Steel; coordinate selection with other Sections supplying similar access panels. Color of panel shall be selected by the Architect.

C. Access panels shall have same fire rating classification as surface penetrated. Rated access panels must have U.L. Label.

PART 3 - EXECUTION

3.01 PRE-BID SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this division. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

C. The documentation of existing conditions was derived from As-Built documents and are in part unverified. Actual existing conditions shall be verified prior to commencement of work.

3.02 FIRE-SUPPRESSION DEMOLITION

A. Refer to individual Division 21 sections for fire-suppression demolition.

3.03 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 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. Type of system configuration as well as pipe sizing, fittings, and any/all system components indicated in the Contract Documents shall be followed without exception. For example, if a looped system configuration is shown, that piping configuration and its associated pipe sizing shall be installed. The same is applicable for tree system configurations, as well as grid system configurations

D. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping to permit valve servicing.

H. Install piping at indicated slopes.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install piping to allow application of insulation.

L. Select system components with pressure rating equal to or greater than system operating pressure.

M. Install escutcheons for penetrations of walls, ceilings, and floors.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. No piping or ductwork shall pass over electrical apparatus. Piping, ductwork or equipment installed in dedicated electrical spaces as defined in NFPA shall be relocated at no additional expense.

3.04 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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: 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.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
   2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

3.05 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting." Unless noted otherwise, all exposed equipment, piping, hangers, etc., shall be painted. Confirm with Owner the color scheme prior to commencing with painting. Unless otherwise directed, each exposed system shall be painted according to the following schedule:

SYSTEM	COLOR
Automatic Sprinkler and Piping	TBD

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

C. Furnish one can of aerosol-free touch-up paint for each different color factory finish which is to be the final finished surface of the product.

3.06 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

D. Fireproofing:
   1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.
   2. Piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
   3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

3.07 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.08 INSTALLATION ONLY ITEMS:

A. Where this contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This contractor shall be responsible for:
   1. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
   2. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

B. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

3.09 COMMISSIONING

A. The Commissioning Authority will be Owner furnished and under direct contract with the Owner. That is, the General Contractor and this subcontractor's bid price shall not include the services of the Commissioning Authority but shall include costs for coordination testing, Contractor commissioning, etc.

END OF SECTION

SECTION 210510

FIRE PROTECTION DEMOLITION AND ALTERATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:
   1. Disconnection of fire protection equipment/piping in selected portions of building or structure.
   2. Demolition and removal of selected fire protection components.
   3. Salvage of existing items to be reused or recycled.

B. Related Requirements:
   1. Division 01 Section "Cutting and Patching."
   2. Division 02 Section "Selective Structure Demolition" for sequencing and scheduling procedures and requirements for demolition activities.

1.03 JOB CONDITIONS

A. Perform all demolition as needed to accomplish new work.

B. Do not rely solely on fire protection drawings to determine extent of general construction demolition. Refer to architectural demolition plans for the exact extent of general construction demolition required by this contract.

C. This Contractor is responsible for all charges, fees etc. incurred as a result of the fire protection portion of the demolition.

D. Prior to demolition or alteration of structures, the following shall be accomplished:
   1. Review available record documents of the existing construction. Owner does not guarantee that existing conditions are same as those indicated in record documents.
   2. Coordinate sequencing with Owner and other Contractors.
   3. Coordinate means to separate construction zones from non-renovated zones to prevent the spread of dust, fumes and debris.
   4. Coordinate means to provide exhaust and makeup air to maintain the construction zone at an adequate negative pressure to contain all construction dust and fumes.
   5. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work.
   6. Equipment/piping noted to be removed and turned over to the Owner, shall be delivered to the Owner at a place and time he so designates.
   7. Where the materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.
   8. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition, at no additional cost to Owner.
   9. Salvage equipment scheduled for reuse in new work or scheduled to be delivered to Owner's storage facility.

E. Disconnect, demolish, and remove fire-protection systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

F. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 DEMOLITION

A. Existing fire protection equipment/piping in conflict with new construction shall be removed and/or relocated as indicated on the drawings, as directed or needed. This Contractor shall remove all fire protection equipment/piping released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. All fire protection components shall be stored on site for Owner assessment. Any components not retained by the Owner shall be removed by the contractor. Properly dispose or remove from site any items not retained by Owner.

B. Any existing services or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction, shall be reconnected in an approved manner. Provide temporary ducts, pipes, controls, etc., as needed to prevent interruption of service to occupied areas caused by demolition operations. In addition, any fire protection, piping or equipment which may require relocation or rerouting as a result of construction, shall be considered a part of the work of this section and shall be done by this Contractor with no additional compensation, provided that the referenced relocation is discernable from the pre-bid review of the site, and associated documents.

C. This Contractor shall remove all fire protection, piping, straps, and existing equipment, being discontinued or removed due to construction. Abandoned or removed services shall be disconnected and capped at the perimeter of the project or as required elsewhere in the documents.

D. The existing building is to remain in operation during construction. This Contractor shall coordinate all work that will interfere with the present operation of the facility with the Owner and Construction Manager.

E. All existing equipment/piping that is to remain shall be cleaned inside and out. Flush all piping and return to clean condition or replace any corroded piping/fittings with new components. All dirt, plaster dust and other foreign matter shall be blown and/or cleaned from all piping, fitting, equipment and hangers. Touch up paint equipment in exposed areas.

F. Fire Protection systems indicated to remain shall be wiped or vacuumed clean both internally and externally to remove all dirt, plaster dust or other foreign materials.

G. Existing fire protection systems that are being extended or modified to serve this project shall be cleaned inside and out in accordance with the National Fire Protection Association standards. This includes the addition of access panels necessary to reach the complete fire protection system components.

H. Existing fire protection in remodeled area that is not being removed shall be sealed as necessary to comply with NFPA standards and requirements of fire protection section of the specifications.

I. All coring that is required for fire protection work shall be done by this Contractor.

J. All cutting and patching required for fire protection work shall be by this Contractor.

K. This Contractor shall provide required additional support for existing fire protection piping and equipment in remodeled area that is not being removed and is not properly supported.

L. When existing fire protection, piping, or related equipment in remodeled areas prevents the installation of other work, remove and reinstall existing materials, making necessary modifications and transitions to coordinate with other trades.

M. Maintain construction zone at adequate negative pressure by providing exhaust by mechanical means until all work which creates dust or fumes is completed.

3.02 CLEANING AND REPAIR

A. Clean existing materials and equipment which remain or are to be reused. Report damage or defects to Architect.

3.03 TESTING

A. Existing equipment shall be tested before demolition begins to determine existing operating conditions and capacities. Upon completion of all new work, the existing equipment shall be rebalanced to serve the new areas and maintain existing capacities in existing areas.

END OF SECTION

SECTION 211313

WET-PIPE SPRINKLER SYSTEMS PERFORMANCE SPEC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gages.
6. Backflow preventer

B. Related Sections:
1. Division 21 Section “Common Work Results for Fire Suppression”.
2. Division 26 Section “Digital Addressable Fire-Alarm System” for alarm devices not specified in this section.

1.02 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.03 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
1. Contractor shall obtain up to date (within 6 months of permit date) fire-hydrant flow test records indicate the following conditions:
a. Date:
b. Time:
c. Performed by:
d. Location of Residual Fire Hydrant R:
e. Location of Flow Fire Hydrant F:
f. Static Pressure at Residual Fire Hydrant R:
g. Measured Flow at Flow Fire Hydrant F:
h. Residual Pressure at Residual Fire Hydrant R:

1.04 SUBMITTALS

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

B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
1. Not less than six (6) sets dated, fire protection contractor’s shop drawings alone with one (1) set of P.E. signed and sealed **exp** U.S. Services Inc. fire protection drawings and calculations shall be submitted to the local Fire Department, and/or authority having jurisdiction for stamped approval. The approved copies shall then be submitted to Architect/Engineer for approval prior to commencing any ordering, fabrication, or installation.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified Installer.

D. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

E. Field quality-control reports.

F. Operation and maintenance data.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

C. Installer Qualifications:
   1. The work performed under this section shall be a [**Insert State, territory or country**] certified Fire Protection Contractor with a minimum of five years' experience.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

B. All 2" and smaller shall be screwed schedule 40 pipe in accordance with ASTM A135/A795. All 2 ½" or greater piping shall be grooved schedule 10 ASTM A135.

2.02 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Grade B Insert grade. Pipe ends may be factory or field formed to match joining method.

B. Roll-grooved Thinwall Galvanized- and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed.

C. Galvanized- and Black-Steel Pipe Nipples: ASTM A 135 or ASTM A 795/A 795M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

E. Galvanized and Uncoated, Steel Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Cast-Iron Flanges: ASME 16.1, Class 125.

G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

H. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Manufacturers: provide products by Victaulic or Victaulic Firelock only.
   2. Pressure Rating: 300 psig minimum.
   3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
   4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
   5. Grooved couplings and mechanical fittings shall be malleable iron, 500 PSI working pressure, in accordance with ASTM A47. Coupling gasket material shall be butyl rubber. Grooved couplings and mechanical fittings shall be tested and listed by UL and/or FM. Style of grooved coupling/fittings shall be Victaulic or Victaulic Firelock only. Any/all grooved mechanical fittings such as; mechanical tees, roust-a-bout, plain end fitting, hookers, etc.

shall not be used unless written permission from Engineer is obtained prior to final bid. (Exception shall be all exterior and dry-pipe system grooved couplings and fittings will be galvanized.)

I. All piping shall have an anti-bacterial film applied to all piping equal to Allied ABFII (five year warranty or 24 flushes) to guard against microbiologically-influenced corrosion.

2.03 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick.

B. Class 125, Cast-Iron Flat-Face Flanges: Full-face gaskets.

C. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.04 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
   1. Valves shall be UL listed and FM approved.
   2. Minimum Pressure Rating: 175 psig.

B. Check Valves:
   1. Manufacturers: Provide one of the following:
      a. Clow Valve Company; a division of McWane, Inc.
      b. Mueller Co.; Water Products Division.
      c. NIBCO INC.
   2. Standard: UL 312.
   3. Type:
      a. Below ground: Swing check listed for underground installation, in an accessible roadway box with gravel bottom.
      b. Above ground: Spring loaded wafer check

C. Gate Valves:
   1. Size 2-1/2” and larger
      a. Flanged OS&Y type or Mueller #B-1
   2. Size 2” and smaller
      a. Butterball type: Grinnell #BB-SCS)1 or Milwaukee equal

D. Indicating-Type Butterfly Valves:
   1. Basis-of-Design Product: Provide the following:
      a. Victaulic Company 705-W

E. Adjustable Wall Post Indicator Valve:
   1. Basis-of-Design Product: Provide the following:
      a. Mueller #A-20814 wall post with B-1 resilient wedge gate valve, U.L. Listed/F.M. approved.
      b. Kennedy #641 post with KS-RW resilient wedge gate valve.

2.05 TRIM AND DRAIN VALVES

A. General Requirements:
   1. Standard: UL listed and FM approved.
   2. Minimum Pressure Rating: 175 psig.

B. Ball Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Milwaukee Valve Company.
      b. NIBCO INC.
      c. Victaulic Company.

2.06 SPECIALTY VALVES

A. General Requirements:
   1. Standard: UL listed and FM approved.
   2.
   3. Minimum Pressure Rating: 175 psig.
   4. Body Material: Cast or ductile iron.
   5. Size: Same as connected piping.
   6. End Connections: Flanged or grooved.

B. Alarm Valves:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Tyco Fire & Building Products LP.
      b. Victaulic Company.
      c. Viking Corporation.
   2. Standard: UL 193.
   3. Design: For horizontal or vertical installation.
   4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.
   5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

2.07 SPRINKLER SPECIALTY PIPE FITTINGS

A. Mechanical-T and -cross fittings: Permitted in retro-fit applications, but only upon prior specific written approval from Engineer
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Reliable
      b. Star MT-1, MT-2, MT-8
      c. Victaulic Company. Get basis of design model#
   2. Standard: UL and FM approved
   3. Pressure Rating: [175 psig minimum] [300 psig].
   4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
   5. Configurations: Cast backing, double bolt, ductile-iron housing with branch outlets.
   6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
   7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Welded Branch Connections
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Merit
      b. Ward
   2. Standard: AWSD10.9 and ANSIB31.1
   3. Body Material: Standard weight black steel. (Galvanized in exterior or corrosive environments.)
   4. Size: Weld branch connections are permitted only when the branch line is more than two pipe sizes smaller than the main. Welded bends or tees shall not be permitted.

C. Flow Detection and Test Assemblies:
   1. Manufacturer: Provide Victaulic #720 or approved equal.

2.08 DRY SPRINKLER PIPE INSULATING BOOT

A. Manufacturers: Subject to compliance with requirements, provide one of the following:'
   1. Viking #13864 with #10 tapping screws.
   2. Tyco Model #DSB-2 with two strap ties and adhesive.

2.09 SPRINKLERS

A. See Drawings for sprinkler model numbers. Any approval of substitution of sprinkler head manufacturers shall be obtained in writing from the Engineer prior to bidding of contract. Extended coverage pendent or upright sprinklers shall not be permitted.

B. Automatic sprinkler heads shall have temperature ratings of fusible elements to be in accordance with NFPA 13. Extended coverage pendent or upright sprinklers shall not be permitted.

C. Furnish spare sprinkler heads of each type, with wrench, in wall mounted cabinet as required by NFPA #13.

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Notifier
      b. Tyco Fire & Building Products LP.
      c. Victaulic Company.
      d. Viking Corporation.
      e. Potter Roemer
   2. Standard: UL 753.
   3. Type: Mechanically operated, with Pelton wheel.
   4. Alarm Gong: Cast aluminum with red-enamel factory finish.
   5. Size: 10-inch diameter.
   6. Components: Shaft length, bearings, and sleeve to suit wall construction.
   7. Inlet: NPS 3/4.
   8. Outlet: NPS 1 drain connection.

C. Water-Flow Indicators:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Notifier
      b. System Sensor; a Honeywell company.
      c. Potter Roemer
   2. Standard: UL 346.
   3. Water-Flow Detector: Electrically supervised.
   4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
   5. Type: Paddle operated.
   6. Pressure Rating: 250 psig.
   7. Design Installation: Horizontal or vertical.

D. Valve Supervisory Switches:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Notifier
      b. System Sensor; a Honeywell company.
      c. Potter Roemer
   2. Standard: UL 346.
   3. Type: Electrically supervised.
   4. Components: Single-pole, double-throw switch with normally closed contacts.
   5. Design: Signals that controlled valve is in other than fully open position.

2.11 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMETEK; U.S. Gauge Division.
   2. Ashcroft, Inc.
   3. Pollard

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 300 psig.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 - EXECUTION

3.01 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping using in-building riser for service entrance to building.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories as required at connection to water-service piping.

3.02 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Install seismic restraints on piping installed in seismic area. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

F. Install sprinkler piping with drains for complete system drainage.

G. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

H. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

I. Install alarm devices in piping systems.

J. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

K. Install pressure gages on riser or feed main and at each sprinkler test connection, Include pressure gages with connection not less than NPS 1/4 and with soft metal seated globe valve,

arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

L. Fill sprinkler system piping with water.

M. Absolutely no grooved fittings or couplings shall be installed in public front-of-house areas.

3.03 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Gaskets shall be full-face, minimum 1/8” thick. Join flanges with gasket and bolts according to ASME B31.9. Grooved flanges or uni-flanges are not permitted.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
   1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.04 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Specialty Valves:
   1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
   2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.05 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels on 1-inch double swing joint return bends. Feed off the top of the branch line.

B. Provide head guards on sprinklers in electrical, telecommunication, and mechanical equipment rooms.

C. Provide sprinklers above and below ductwork, obstructions, or combinations of obstructions over four (4) feet wide.

D. Install dry-type sprinklers with water supply from heated space with dry sprinkler insulating pipe boot assembly. Do not install pendant or sidewall, wet-type sprinklers in areas subject to freezing.

3.06 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

3.07 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 16 Section "Identification for Electrical Systems."

3.08 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.
   1. Leak Test: After installation, charge systems, including yard piping and test for leaks. Hydrostatic test at not less than 200 psi pressure for two (2) hours, or at least 50 psi above maximum system pressure, whichever is greater. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
   4. Energize circuits to electrical equipment and devices.
   5. Coordinate with fire-alarm tests. Operate as required.
   6. Coordinate with fire-pump tests. Operate as required.
   7. Verify that equipment hose threads are same as local fire-department equipment.

B. Prepare test and inspection reports.

3.09 CLEANING

A. The entire system shall be flushed with clean water to remove debris resulting from installation.

B. Provision shall be made for the disposal of water issuing from test outlets to avoid property damage.

C. Remove and replace sprinklers with paint other than factory finish.

3.10 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.

B. Wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:
   1. Standard-weight, black-steel pipe with threaded ends; uncoated, steel threaded fittings; and threaded joints. Galvanized piping shall be used in exterior and corrosive areas.

C. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 6, shall be one of the following:

1. Thinwall black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints. Galvanized piping shall be used in exterior and corrosive areas.
2. Piping installed in areas exposed to guest view shall be threaded. Grooved coupling are not permitted in guest areas.

END OF SECTION

SECTION 220500

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Grout.
   5. Equipment installation requirements common to equipment sections.
   6. Painting and finishing.
   7. Concrete bases.
   8. Supports and anchorages.

1.03 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Actual Air: Air delivered at air-compressor outlet. Flow rate is compressed air delivered and measured in ACFM.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. 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.

E. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

F. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

G. D.I.S.S.: Diameter-index safety system.

H. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

I. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

J. 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.

K. 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.

L. High-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures between 150 and 200 psig.

M. Low-Pressure Compressed-Air Piping: System of compressed-air piping and specialties operating at pressures of 150 psig or less.

N. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

O. LP Gas: Liquefied-petroleum fuel gas.

P. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

Q. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

R. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in SCFM.

S. Tepid: Moderately warm.

T. The following are industry abbreviations:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. BR: Butyl rubber.
3. Buna-N: Nitrile rubber.
4. CPVC: Chlorinated polyvinyl chloride plastic.
5. CR: Chlorosulfonated polyethylene synthetic rubber.
6. CSM: Chlorosulfonyl-polyethylene rubber.
7. CWP: Cold working pressure;
8. EPDM: Ethylene-propylene-diene terpolymer rubber.
9. FOG: Fats, oils, and grease.
10. FPM: Vinylidene fluoride-hexafluoro propylene copolymer rubber.
11. FRP: Fiberglass reinforced plastic.
12. HDPE: High-density polyethylene plastic.
13. HVE: High-volume (oral) evacuation.
14. LLDPE: Linear, low-density polyethylene plastic.
15. LPG: Liquefied-petroleum gas
16. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
17. NBR: Acrylonitrile-butadiene rubber.
18. NR: Natural rubber.
19. NRS: Non-rising stem.
20. OS&Y: Outside screw and yoke.
21. PE: Polyethylene plastic.
22. PP: Polypropylene plastic.
23. PMMA: Polymethyl methacrylate (acrylic) plastic.
24. PTFE: Polytetrafluoroethylene plastic.
25. PUR: Polyurethane plastic.
26. PVC: Polyvinyl chloride plastic.
27. PVDF: Polyvinylidene fluoride plastic.
28. RS: Rising stem.
29. SWP: Steam working pressure.
30. TFE: Tetrafluoroethylene plastic.
31. TPE: Thermoplastic elastomer.
32. uPVC: Unplasticized Polyvinyl chloride plastic.
33. WAGD: Waste anesthetic gas disposal.

1.04 SCOPE

A. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work may not be specifically shown or specified, provide supplementary or miscellaneous items,

appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

B. It is the intent that these Specifications and associated Drawings establish minimum requirements for products and equipment with the intent to provide plumbing systems finished, tested and ready for operation. Incidental detail that is not shown or specified, but necessary for proper installation and operation shall be included in the work and in these Contractor's estimates, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each pipe and piece of equipment to minimize conflicts with other trades.

C.]Information and components shown on riser diagrams but not shown on plans, and vice versa, shall be provided as if expressly required on both.

D. It is the requirement of these Contract Documents to have the contractors provide systems and components that are fully complete, operational and suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the Contractor has failed to notify the Architect of the situation the Contractor shall include the specific components or subsystems with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

1.05 MODIFICATIONS IN LAYOUT

A. Drawings are intended to outline the scope of work required and are not intended to be installation drawings. Drawings are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component nor do they show the exact routings. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational, nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet Architectural requirements.

B. Unless specifically stated to the contrary, no measurement of a drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

C. Prior to installation of visible material and equipment (including access panels) in finished spaces, review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

D. Check Contract Documents, as well as, Submittals and Shop Drawings of all subcontractors to verify and coordinate spaces in which work of Divisions 21 through 28 will be installed.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades. Systems shall be run parallel with or perpendicular to major architectural and structural building elements.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.06 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.

2. Dielectric fittings.

B. Welding certificates.

1.07 COORDINATION

A. Coordinate arrangement, mounting, and support of piping and equipment:
   1. To maintain maximum headroom; all piping, duct, conduit and associated components to be as tight as possible to underside of structure to provide for ease of disconnecting the equipment with minimum interference to other installations.
   2. To allow right of way for piping installed at required slope.
   3. To 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."

1.08 COORDINATION DRAWINGS

A. When included as part of the Contract Documents, there shall be full cooperation and coordination of all specialty trades.

1.09 RECORD DOCUMENTS

A. Record Drawings are specified in Division 01 Section "Project Record Documents."

B. The Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing pipe, valve, and piece of equipment. Record documents are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner in both electronic and hard paper copy formats. Record drawings shall also include:
   1. Locations of buried piping or similar items. Include buried depth.
   2. Field changes of dimension or detail.
   3. Changes made by field order or change order.
   4. Details not on original contract drawings.

1.10 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in a coordinated manual. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.
   1. Copies of all approved submittals/shop drawings.
   2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.
   3. Startup and shutdown procedures.
   4. Flow diagrams.
   5. Test records.
   6. Wiring diagrams.

7. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment.
8. Owner's written acknowledgement of satisfactory completion of instruction period.

C. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

D. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions.

1.11 SUBMITTAL PROCEDURE AND FORMAT

A. This Article supplements Division 1.

B. Submittal Cover Sheet
1. Submittal data for each product shall include a copy of the following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
2. Shop drawings/submittals shall be submitted according to applicable specification section's requirements with a separate cover sheet completed for each product, rather than one cover sheet for multiple products, whether or not supplied by one manufacturer or vendor.

SUBMITTAL DRAWING COVER SHEET				
PROJECT:		CONTRACTOR:		
DIVISION NO.:		SECTION NO.:		
DESCRIPTION:				
CONTRACT DRAWING REFERENCE NO:				
EQUIPMENT TAG:				
SUBMISSION (CIRCLE ONE): FIRST, SECOND, THIRD, FOURTH				
DATE:				
INFORMATION AND CHECKLIST				
1.	Contractor's Log #ID			
2.	Name, address, and phone number of supplier.			
3.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes	No	
4.	Is this item a substitution?	Yes	No	
5.	Are deviations clearly identified?	Yes	No	
6.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
7.	Has support, erection, weights, and installation been coordinated with all trades?	Yes	No	
8.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes	No	
9.	Does this material/equipment add expense to any other trade or project costs?	Yes	No	
10.	Does equipment require interface with other trades? List divisions and specifics requiring coordination?	Yes	No	
11.	Is control interface coordinated?	Yes	No	
12.	List electrical characteristics (V/Ph/A)			

C. Multiple Re-submittals: The Engineer will review the first submittal from the contractor and respond with comments, and will review one re-submittal for the same item(s) from the contractor and respond with comments. If the contractor is required to make subsequent submittals for the same item(s) the Engineer shall be compensated by the contractor for the time to review each subsequent re-submittal. The contractor shall agree to compensate the Engineer a minimum of $500 per each re-submittal item.

D. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be 1/4 inches = 1 foot 0 inch scale unless specified otherwise.

E. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.

F. Provide shop drawing submittals showing details of piping connections to ALL equipment. If connection details are not submitted and connections are found to be installed incorrectly in the field, this contractor shall reinstall them within the original contract price.

G. Shop drawings for different systems and equipment shall be bound separately by specification section as indicated above and not bound by manufacturer. Each separate submittal shall have its own transmittal and cover letter. Submittals which contain different specification section systems bound together may be returned un-reviewed for re-submittal.

1.12 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. All piping materials shall bear label, stamp, or other markings of specified testing agency, including but not limited to Underwriters Laboratory (UL) and the Cast Iron Soil Pipe Institute (CISPI).

D. Electrical Characteristics for Plumbing Equipment: Equipment of different 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 at the contractor’s expense. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

E. All electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Skid-mounted or packaged assemblies shall be listed and labeled as an assembly, not just the individual components.

F. Fire-Resistance Ratings: Where indicated, provide penetration firestopping devices tested for fire resistance per ASTM E 814 by a testing agency acceptable to authorities having jurisdiction. Indicate design designations from UL's "Fire Resistance Directory."

G. Installer Qualifications:

1. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.
2. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.
3. Pressure-Seal Joining Procedure for Steel Piping. Qualify operators according to training provided by Victaulic Company.
4. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or to AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
5. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

H. NSF Standard: Comply with NSF 61, “Drinking Water System Components – Health Effects,” for all components, including piping, equipment, and fixture material that will be in contact with potable water. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

I. Acceptable Manufacturers
1. The Engineer’s design for each product is based on the manufacturer listed in the schedule or shown on the drawings. In Part 2 of some technical specifications, other manufacturers are listed as being acceptable. The listing of a manufacturer as acceptable does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. These are acceptable only if, as a minimum, they:
   a. Meet all performance criteria listed in the schedules and outlined in the specification.
   b. Have identical operating characteristics to those called for in the specification. For example, a two-stroke diesel generator will not be acceptable if a four-stroke model is specified.
   c. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer’s name appears as acceptable shall not be taken to mean that the Engineer has determined that the manufacturer’s products will fit within the available space - this determination is solely the responsibility of the contractor.
   d. Products must adhere to all architectural considerations including but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.
   e. All equipment shall be labeled or listed by the National Board of Underwriters Laboratories (U.L.) where such labeling or listing exists for such material.

1.13 TEMPORARY SERVICES/CONTINUITY OF UTILITY SERVICES

A. In the absence of specific requirements in Division 1, comply with the following procedures for shut-downs.

B. Provide temporary services where project construction schedule requires extended shut downs of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shut downs are interruptions of existing services for a period of time longer than that acceptable to the Owner.

C. Contractor shall coordinate any shutdowns of existing systems as follows:
1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.
2. Minimize timeline of shutdowns of any system.
3. Provide temporary services where required and perform shutdowns and tie-ins at a time convenient to Owner.

4. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.
6. All life safety systems shall be returned to service at the end of each work day, when work is being performed on the systems. It is the responsibility of the Contractor to provide all associated appurtenances necessary to ensure that the systems are in proper working condition at all times.

1.14 DELIVERY, STORAGE, AND HANDLING

A. Store ALL plastic piping and valves protected from direct sunlight. Support to prevent sagging and bending.

B. Protect equipment/materials from damage during shipping, storage, handling and installation. Delivery equipment/materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

C. The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic. Specialties shall not be stored outdoors.

D. Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional expense. Do not store equipment with PVC material with exposure to direct sunlight.

E. Deliver fuel gas and medical gas 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.

1.15 PERFORMANCE REQUIREMENTS

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection. This is applicable for all Division 22 sections.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

2.03 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. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. 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.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

2.04 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   2. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.

B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. 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.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.

2.05 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: Pipe sizes 2 and smaller, factory-fabricated, union assembly, for 300-psig minimum working pressure at 180 deg F.

D. Dielectric Flanges: Pipe sizes 2-1/2” and larger, factory-fabricated, companion-flange assembly, for 300-psig minimum working pressure as required to suit system pressures.

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. 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.

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.

2.06 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.07 FLASHING MATERIALS

A. All piping through roofs shall be flashed. Flashing materials and methods shall be in accordance to the manufacturer's requirements.

2.08 CEILING ACCESS AND ACCESS PANELS

A. Access panels are generally not shown on the drawings, but they are required to be provided by Contractor.

B. Furnish access panels for installation under other Sections valves or other items installed under this Division require access and are concealed in floor, wall, furred space or above ceiling. Access panels shall be by Milcor, Knapp, Nystorm or Inland Steel; coordinate selection with other Sections supplying similar access panels. Color of panel shall be selected by the Architect. Unless noted otherwise on the drawings, to be stainless steel.

C. Access panels shall have same fire rating classification as surface penetrated. Rated access panels must have U.L. Label.

PART 3 - EXECUTION

3.01 PRE-BID SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this division. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Install all piping, systems, equipment, etc. per local code and per the local authority having jurisdiction's (AHJ) requirements. Should the any part or component of the drawings or specifications conflict with the local code requirements, the local code requirements shall prevail. The contractor shall inform the design team immediately of any code conflicts.

C. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

D. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. To maintain maximum headroom, all piping, duct, conduit, and associated components shall be installed as tight as possible to underside of deck/structure to provide for ease of disconnecting the equipment with minimum interference to other installations.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

H. Install piping to permit valve servicing.

I. Install piping at indicated slopes.

J. Install piping free of sags and bends.

K. Install fittings for changes in direction and branch connections.

L. Install piping to allow application of insulation.

M. Select system components with pressure rating equal to or greater than system operating pressure.

N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

O. Verify final equipment locations for roughing-in.

P. Perform work and provide material and equipment as shown on Drawings and/or as specified and/or indicated in this Section of the Specifications. Completely coordinate work with work of other trades and provide a complete and fully functional installation.

Q. All exposed piping, fittings, valving, and devices located in under lavatories and in all food service locations shall be provided with a chrome finish. As an alternate all copper pipe and tube is allowed to be provided with chrome paint in lieu of chrome plating.

3.03 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.

3.04 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, 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.

3.05 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.

3.06 CONCRETE BASES

A. Provide raised concrete pads for all floor mounted equipment.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes (if applicable) at Project. Where specific requirements are not specified in Division 3 or detailed on the Drawings, comply with the following at a minimum:
   1. Construct concrete bases 4 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated.
   2. Edges of concrete bases shall have a minimum 1-1/2 inch chamfer.
   3. 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.
   4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.
   7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   8. Use 3000-psi, 28-day compressive-strength concrete with wire-mesh reinforcement.

3.07 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.

D. Fireproofing:
   1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.
   2. Piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
   3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

3.08 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.09 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.

3.10 WELDING

A. Weld only by approved acetylene or electric welding processes and welders shall hold certificate from approved insurance company.

B. Conduct test to demonstrate suitability of procedures to be used in making welds, which conform to specified requirements.

C. Specification for welding procedure shall meet requirements of Welding Qualifications, Section IX, ASME Boiler and Pressure Vessel Code and ANSI B31.1.

D. Align components. No strain shall be placed on weld during welding. No part of pipe shall be offset more than 20% of thickness. Set flanges and branches properly.

E. Welder and Brazing Qualification:
   1. Test welders to demonstrate ability to make acceptable welds. Tests conducted for qualification of welder for work under one Division or Section shall not necessarily qualify welder for work under another Division or Section.
   2. Tests shall be as prescribed for welder qualification in Section IX of the ASME code.
   3. Records of such tests shall be as follows: Each welder shall be assigned an identifying number, letter or symbol. Identifying mark shall be stamped adjacent to welds made by this welder. Identification shall be at top of horizontal piping and at front of vertical piping.
   4. Maintain record of welders employed, showing dates and results of tests and identifying mark assigned to each welder. Certify records and make them accessible to Owner's project representative and/or project manager. Before completion of project, one copy of records shall be turned over to Owner.
   5. No qualification shall be older than three years when welder commences work on this project. If welder has not welded in required welding process for a period of six months, he shall be re-certified.

F. Welding Tests
   1. As designated by Architect, remove welds for destructive testing or for testing by non-destructive means. Tests shall be as determined by Architect.
   2. If, in Architect's opinion, welds so tested do not meet requirements of Sections VIII and IX of ASME, then the Contractor shall pay for the costs of the tests. Remove welds welded by that welder, at no cost to the Owner. Rewelding shall be performed by qualified welder other than welder whose welds did not pass test. Welders whose welds were defective shall not be employed on site for remainder of project.
   3. Welding of stanchions, brackets, anchors and other welding not performed on pipe joints shall be in accordance with requirements of AWS specifications and requirements.

3.11 MISCELLANEOUS TESTING AND BALANCING

A. Tests for piping systems and equipment shall be performed as specified in their respective specification sections.

B. No part of any underground work shall be covered until after it is inspected, tested, approved, and photographed.

C. Provide all equipment required for testing, including fittings for additional openings as required.

D. Notify the Architect and any Inspectors required to observe the test, at least 48 hours prior to when the test is ready to be performed.

E. The General Contractor is responsible for certifying in writing, the results of all testing of systems and equipment in this contract. These written results will be required at project close-out.

F. Include description and what portion of the system has been tested. Record date, time, test medium and pressure used, name and title of the person certifying the test. This person shall sign the certification. Forms and data must be legible.

G. When equipment or systems fail to meet minimum test requirements, replace or repair defective work or materials as necessary, and repeat the inspection and test. Make repairs with new materials. No caulking of holes or screwed joints will be allowed.

H. Maintain complete records at the job site of all testing that has been certified. At completion of the project, include in the instruction manuals clearly legible copies of all test approval records and certification.

I. Balance the entire new water distribution system. Set all balancing valves for proper flow control of all circulating water.

J. All flushing valves, pressure regulating valves, or other regulating devices shall be adjusted for proper balancing and flow to the plumbing fixture and/or equipment.

3.12 EXPANSION PROVISIONS

A. Installation of piping must allow for expansion using offsets, loops, swing joints, expansion joints, etc., as necessary to prevent undue strain. Take-offs from mains to run-outs shall not have less than a three-elbow swings.

B. Mains and risers with loops or offsets shall be securely anchored to structure so as to impart expansion toward loops or offsets. Anchors shall be constructed of heavy forged wrought iron, secured to pipe and to structure. Provide vibration isolation as required.

C. Provide pipe alignment guides as required to guide expanding pipe to move freely from anchor points toward expansion joints, offsets, etc.

3.13 INSTALLATION ONLY ITEMS

A. Where this contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This contractor shall be responsible for:
   1. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
   2. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

B. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within

one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

3.14 CLEANING

A. Cleaning shall be performed prior to system start-up.

B. Piping
   1. General:
      a. After all piping systems have been pressure tested and approved for tightness, flush and clean piping as required by codes.
      b. Furnish materials and labor necessary to flush and clean piping.
      c. Contractor to provide a portable temporary pumping apparatus for the purpose of flushing and cleaning, if required. Pump shall be adequate to provide the required velocities necessary for the process.
      d. When external surfaces of piping are rusted, clean and restore surfaces to original condition.
   2. Flushing:
      a. All water side equipment control valves, strainers, etc., shall be bypassed prior to and during the flushing process.
      b. Flush all water systems clear of all dirt and foreign matter with all pumps bypassed. All flushing to be at a flow rate of 6 f.p.s.
      c. Once flushing is complete and prior to cleaning, all final connections to equipment shall be performed.
      d. Water samples taken from the system during flushing shall determine when the system is ready for the cleaning process.
   3. Cleaning:
      a. Clean all pipeline strainer baskets and return to original condition or replace with new baskets prior to the pipe cleaning process.
   4. Equipment
      a. After completion of project, clean the exterior surface of all equipment, including concrete residue, dirt, paint residue, etc.
      b. Clean all equipment and plumbing fixtures, as recommended by manufacturer.
      c. Thoroughly disinfect all water heating equipment and the complete new domestic water piping system according to Department of Health requirements.
      d. All dirt, plaster dust and other foreign matter shall be blown and/or cleaned from coils, terminal devices, diffusers, registers, and grilles.
      e. Thoroughly clean equipment of all stains, paint spots, dirt, and dust. Remove all temporary labels not used for instruction or operation.

END OF SECTION

SECTION 220501

SAFINGS

PART 1 - GENERAL

1.01 QUALITY ASSURANCE

A. All material shall be marked with type and grade.

1.02 SUBMITTALS

A. Submit shop drawings on all items specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials shall be new unless noted otherwise.

2.02 SAFINGS

A. Four (4) pound sheet lead, FS QQ-L-201.

B. Chlorinated polyethylene (CPE) as manufactured by the Noble Company under the trade name Chloraloy 240.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install safing for all floor drains. Extend safing to 18 inches from edge of drain. Safing shall be clamped to floor drain body and pitched to drain to weep holes. Floor drains installed on grade do not require safing.

3.02 TESTING

A. Safings shall be subject to a standing water test to detect leaks and proper drainage to weep holes of floor drain.

END OF SECTION

SECTION 220519

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Bimetallic-actuated thermometers.
   2. Liquid-in-glass thermometers.
   3. Thermowells.
   4. Dial-type pressure gages.
   5. Gage attachments.

1.02 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   1. Manufacturers:
      a. Marsh Bellofram.
      b. Trerice, H. O. Co.
      c. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
      d. Weiss Instruments, Inc.
   2. Pressure gauge shall be 3-1/2 inch die cast aluminum case, double strength glass window, readable dial scale with gradations from 0 psi to 200 psi, phosphor bronze bourdon tube, brass socket. Provide shutoff valve with pressure gauge. Shall be equal to Trerice Series #600. (Indoor, non-corrosive, non-wet environment.)
   3. Pressure gauge shall be 3-1/2 inch stainless steel case, glass window, readable dial scale with gradations from 0 psi to 200 psi , phosphor bronze bourdon tube, brass socket. Provide shutoff valve with pressure gauge. Shall be equal to Trerice Series #890. (Outdoor, wet or corrosive environment.)

2.02 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 based on gage connection size, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass or stainless-steel needle with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install pressure gages in piping tees with gage located on pipe at the most readable position.

B. Install valve and snubber in piping for each pressure gage for fluids.

C. Install pressure gages in the following locations:
   1. Where noted on the drawings.

D. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

E. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION

SECTION 220523

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Bronze ball valves.
   2. Bronze swing check valves.
   3. Lubricated plug valves.
   4. Pressure Reducing Valves

B. Related Sections:
   1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
   2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.02 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.03 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

B. Valve Sizes: Same as upstream piping unless otherwise indicated.

C. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.

2. Handlever: For quarter-turn valves NPS 6 and smaller.
3. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.

D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

E. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

2.02 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves – Lead Free with Stainless-Steel Trim:
1. Manufacturers:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. NSF/ANSI 61 Section 8 – Lead Free
e. NSF/ANSI 372 Listing – Lead Free
f. Body Design: Two piece.
g. Body Material: Bronze.
h. Ends: Threaded.
i. Seats: PTFE or TFE.
j. Stem: Stainless steel.
k. Nut: Stainless Steel
l. Ball: Stainless steel, vented.
m. Port: Full.
n. Handle: Stainless steel.

2.03 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc – Lead free:
1. Manufacturers:
a. Crane Co.; Crane Valve Group;
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
2. Description:
a. Standard: MSS SP-80, Type 3.
b. NSF/ANSI 61 Section 8 – Lead Free
c. NSF/ANSI 372 Listing – Lead Free
d. CWP Rating: 200 psig.
e. Body Design: Horizontal flow.
f. Body Material: ASTM B 62, bronze.
g. Ends: Threaded.
h. Seat Disc: PTFE.

B. Class 150, Bronze Swing Check Valves with Bronze Disc:
   1. Manufacturers:
      a. Crane Co.; Crane Valve Group;
      b. Milwaukee Valve Company.
      c. NIBCO INC.
   2. Description:
      a. Standard: MSS SP-80, Type 3.
      b. CWP Rating: 300 psig.
      c. Body Design: Horizontal flow.
      d. Body Material: ASTM B 62, bronze.
      e. Ends: Threaded.
      f. Disc: Bronze.

2.04 LUBRICATED PLUG VALVES

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
   1. Manufacturers:
      a. Nordstrom Valves, Inc.
      b. Hammond
   2. Description:
      a. Standard: MSS SP-78, Type II.
      b. CWP Rating: 200 psig.
      c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      d. Plug: Cast iron or bronze with sealant groove.

B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
   1. Manufacturers:
      a. Nordstrom Valves, Inc.
   2. Description:
      a. Standard: MSS SP-78, Type II.
      b. CWP Rating: 200 psig.
      c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      d. Plug: Cast iron or bronze with sealant groove.

C. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
   1. Manufacturers:
      a. Homestead Valve; a division of Olson Technologies, Inc.
      b. Milliken Valve Company.
      c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
   2. Description:
      a. Standard: MSS SP-78, Type IV.
      b. CWP Rating: 200 psig.
      c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
      d. Plug: Cast iron or bronze with sealant groove.

2.05 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
   1. Manufacturers:
      a. Watts Industries, Inc.; Water Products Div.
      b. Zurn Plumbing Products Group; Wilkins Div.
      c. Cla-Val
   2. Standard: ASSE 1003.

a. Meeting NSF/ANSI 372 Listing – Lead Free

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 and smaller. Use butterfly valves for piping NPS 2-1/2 and larger.

F. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

G. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

3.03 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

B. Set field-adjustable pressure set points of water pressure-reducing valves.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

3.05 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG OR LESS)

A. Pipe NPS 2 and Smaller: Note valves do not need to meet NSF standards

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with all stainless-steel trim.
3. Bronze Lift Check Valves: Class 150, bronze disc.
4. Bronze Swing Check Valves: Class 150, bronze disc.

3.06 HIGH-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 TO 200 PSIG)

A. Pipe NPS 2 and Smaller: Note valves do not need to meet NSF standards.
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with all stainless-steel trim.
   3. Bronze Lift Check Valves: Class 150, bronze disc.
   4. Bronze Swing Check Valves: Class 150, nonmetallic disc.

3.07 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: All valves must meet NSF/ANSI 372 Listing – Lead Free standards.
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   3. Bronze Swing Check Valves: Class 125, nonmetallic disc.

END OF SECTION

SECTION 220529

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED WORK

A. Insulation Requirements: Refer to Section 220700 – Plumbing Insulation

1.03 QUALITY ASSURANCE

A. Applicable standards, latest edition:
   1. MSS SP-58, Pipe Hangers and Supports - Material, Design and Manufacture.
   2. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
   3. MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.
   4. MSS SP-90, Guidelines on Terminology for Pipe Hangers and Supports.
   5. For fire protection service:
      a. NFPA 13, Installation of Sprinkler Systems, Article 2-6, Hangers
      b. UL 203, Standard for Pipe Hanger Equipment for Fire Protection Service
   6. For electrical service:
      a. National Electrical Contractor's Association (NECA) NECA – Standard of Installation.
      b. National Electrical Manufacturer's Association (NEMA).

B. Manufacturer's name, part number and applicable size to be stamped on part for identification.

1.04 SUBMITTALS

A. Submit manufacturer's catalog literature showing: details of construction, material of manufacture, assembly details, and load ratings for: upper attachment, middle attachment (rod), pipe attachment, riser clamps, shields and saddles, sway braces, inserts, etc.

B. Submit schedule of manufactured hanger and support devices, indicating type of service, type of device for each range of pipe size.

1.05 DESIGN CRITERIA

A. Provide supporting devices for installation of mechanical equipment and materials.

B. Hangers and supports to be standard design and adequate to maintain supported load in proper position under operating conditions. Pipe and attachments connected to equipment to be supported to prevent piping loads being transmitted to equipment.

C. Type of service is defined to mean either "corrosive service" or "normal service". For purposes of this specification, "corrosive-service" mechanical support devices to be used:
   1. Outdoors.

D. Coordinate support of mechanical, plumbing, electrical, life support systems, and other trades. Piping, ductwork, conduit, etc. located in same area running parallel is to be supported on similar supports.

E. Where piping can be grouped to allow use of trapeze type supports, supporting steel to be standard structural shape or continuous insert channel.

F. Provide supporting steel, not indicated on structural drawings, that is required for installation of mechanical equipment and materials, including angles, channels, beams, etc., to suspend or floor support tanks and equipment.

G. Bracing to be constructed of same material used for support.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Products are identified by [model designations in square brackets] from various manufacturers, including Grinnell Corp./Power Strut (Figure No. prefaced with a “G” or “PS”) or B-Line Systems Inc. (Model No. includes “B”) and are to be used as a guide to establish standard of construction and do not exclude unlisted manufacturers with similar products. (Other manufacturers include: PlastiFab, PHD Manufacturing Inc, Unistrut, Elcen, Kindorf, Fee & Mason, Michigan Hanger, etc.)

B. Listing of manufacturer as “acceptable” does not constitute approval by Engineer. Contractor is responsible for ensuring that submittals are for products that meet or exceed specification requirements and are fit for intended service.

2.02 MATERIALS

A. Hanger and support assemblies to be products of single manufacturer and to be of uniform and compatible parts such that no single element compromises the corrosion resistance of the assembly.

B. FRP materials: polyester or vinyl ester resins reinforced with multiple strands of glass fiber filaments, alternating layers of glass mat and ultraviolet resisting surface veils. Polyester materials to be color-coded gray, vinyl ester materials to be color-coded beige/tan.

C. Galvanizing and/or epoxy treatment of carbon steel components to occur during factory fabrication, and field application or field modifications that compromise corrosion resistance will not be accepted.

2.03 HANGERS & SUPPORTS

A. Upper Attachments
   1. Beam Attachment (Bottom Flange)
      a. Corrosive service:
         1) Clamps to be stainless steel or FRP when used in conjunction with stainless steel or FRP threaded rod. [Aickinstrut RGBC / BBFPU751]
      b. Normal service
         1) Piping 2 in. and under: malleable iron C-clamp, (MSS SP-58 TYPE 19), UL listed, [G92-G94 / B3031-B3034]
         2) Piping 2½ in. and larger: forged steel UFS beam clamp (MSS SP-58, TYPE 28 or 29), UL listed, [G292 / B3291-3298]
   2. Concrete Attachment
      a. Corrosive service:
         1) Continuous concrete insert or concrete embedment channel of FRP construction, and pipe-supporting devices made specifically for use with insert or channel and for corrosive service [Aickinstrut 20E-2300 / BFP22, BFV22].
      b. Normal service:
         1) Wedge type cast-in-place concrete insert, (MSS-SP69, TYPE 18), embedded in concrete, UL listed for pipe ¾ in. through 8 in., [G281, B2505-B2508]
         2) Clevis concrete plate, electro-plated steel plate for attachment to concrete ceilings, with hex head cap screws and hex nuts or clevis pin and cotter pin, forged steel weldless eye nut, [G49, G290 / B3086, B3200]
      c. Continuous concrete insert or concrete embedment channel, and pipe-supporting devices made specifically for use with insert or channel [PS349, PS449 / B221, B321,521]

3. Steel Joist Attachment:
    a. Corrosive service:
        1) Not applicable.
    b. Normal service
        1) Piping 2 in. and under heavy-duty carbon steel washer plate on top of channels or angles with rods or U-bolts with double locking nuts. [G60 / B3248]
        2) Piping 2½ in. and larger: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket. [G66, G290 / B3083, B3200]

B. Middle Attachment (Hanger Rod):
    1. Corrosive service:
        a. Pultruded vinyl ester resin ATR (all threaded rod), with vinyl ester square nits or polyurethane hex nuts. [Aickinstrut 200-38XX / BFVATR]
    2. Normal service:
        a. Electro-galvanized carbon steel continuously threaded rod, with adjusting and lock nuts. [G146 / B3205]

C. Pipe Attachment
    1. Corrosive service:
        a. Hand-wrapped fiberglass, glass reinforced polyurethane, plastic composite material or stainless steel clevis type hangers. [Aickinstrut CVHPU / BFP3104 / StrutTech CHX00PU]
    2. Normal service:
        a. suspended adjustable clevis (MSS SP-58 TYPE 1)
            1) For suspended steel or cast iron pipe or conduit, adjustable clevis, UL listed. [G260 / B3100 or B3102]
            2) For suspended copper pipe or tubing, adjustable clevis, copper plated (or PVC coated). [GCT-65 / B3104CT]
        b. suspended steel yoke pipe roll (MSS SP-58 TYPE 43), suspended piping, steel or copper, 2½ in. or less, [G181 / B3110]
        c. bottom supported pipe roll stand (MSS SP-58 TYPE 44), bottom supported piping, steel and copper [G271 / B3117SL]

D. One Hole Conduit Strap:
    1. Corrosive Service:
        a. For supporting ¾ inch PVC coated RGS stainless steel: approximately 7 pounds per 100 units.
    2. Normal service:
        a. For supporting ¾ inch EMT or rigid metal conduit: galvanized steel; approximately 7 pounds per 100 units.

E. Two Hold Conduit Traps:
    1. Corrosive Service:
        a. For supporting 1 inch and larger PVC coated RGS stainless steel: ¾ inch strap width.
    2. Normal Service:
        a. For supporting 1 inch and larger EMT or rigid metal conduit: galvanized steel, ¾ inch strap width.

2.04 MULTIPLE OR TRAPEZE HANGERS

A. Struts and structural shapes/supports
    1. Corrosive service:
        a. Constructed from pultruded premium grade resin meeting ASTM E-84 Class 1 Flame Rating and self-extinguishing requirements of ASTM D-635. Resin material to have maximum glass content of 50% and use synthetic surfacing veil for maximum chemical and ultraviolet protection.

b. Use vinyl ester resin for "ozone" applications, such as Hetron FR 992 by Ashland Chemical or approved substitute by Dow.
c. To be either polyester or vinyl ester resins for general applications.
d. Cut edges to have sharp edges ground smooth and sealed with compatible resin or epoxy sealer.

2. .Normal service:
a. Constructed from 12 gauge roll formed ASTM A446 Grade A structural steel channel, 15/8“ x 15/8“ minimum strut. [PS200 / B22]
b. Struts and structural shapes/supports to be finished with a Dura-Green Epoxy coating.

2.05 FLOOR MOUNTED SUPPORTS

A. Corrosive service:
1. Fabricated, floor mounted pipe supports to be manufactured of fiberglass, Type 6061 T-6 aluminum, or PVC pipe sections and fittings, with following provisions:
a. Fiberglass supports to be designed against minimum 9:1 design stress ratio and finished with corrosion resistant gloss coat.
b. Aluminum to be Type 6061 T-6 and provided with epoxy coating specified below.
c. PVC pipe sections and fittings may be used for supports where lightly loaded. Floor stands to consist of Schedule 80 PVC pipe sections with solvent-welded saddles top and flanged fittings at bottom, anchored to floor with no less than four bolts, use full size bolts for 150 lb. drilling pattern. Face and backing ring of flange to be one piece construction (not Vanstone type).
d. 304 stainless steel or 316 stainless steel post blast, struts and fittings. Note: Use 316 stainless steel in and around salt water environments.

B. Normal service:
1. Floor mounted pipe supports to be constructed of galvanized steel with epoxy coating.

2.06 PIPE CLAMPS / ANCHORS / HORIZONTAL SUPPORT

A. Corrosive service:
1. Glass-reinforced polyurethane clamps secured with Type 316 stainless steel bolts. [Aickinstrut PCR Type I / BFP2008-BF2017]
2. Adjustable pipe straps or clamps with non-metallic bolts are not to be used.
3. Other manufacturers include: StrutTech (Entrum Industries Inc.), FRP Supply Company, IMCO Reinforced Plastics, Inc.

B. Normal service:
1. Pipe clamps to be constructed of galvanized steel with an epoxy coating.

2.07 RISER CLAMPS / VERTICAL SUPPORT

A. Corrosive service:
1. To be constructed of stainless steel, with stainless steel bolts.
2. On small systems, clamps constructed of FRP may only be used with Engineer’s pre-approval.

2.08 SADDLES & SHIELDS

A. Corrosive service:
1. Pipe Shield, B-Line or Insul-Shield. Construct thermal pipe shields of high density, 100 psi, waterproofed calcium silicate encased in corrosion resistant FRP shield.
2. Insulation insert to be same thickness as adjoining pipe insulation and extend 1" beyond FRP shield on piping requiring vapor barrier. Thermal conductivity of insulation to not exceed 0.30 at 75 °F mean temperature.
3. If hanger spacing exceeds 10 feet, use double layer shield on bearing surfaces.
4. Minimum shield lengths.

Pipe Size	Minimum Length
Up through 1 1/2-inch	4-inch
2-inch through 6-inch	6-inch
8-inch through 10-inch	9-inch

B. Normal service:
   1. Pipe Shield, B-Line or Insul-Shield. Construct thermal pipe shields of high density, 100 psi water-proofed calcium silicate encased in corrosion resistant sheet metal shield.
   2. Insulation insert to be same thickness as adjoining pipe insulation and extend 1" beyond sheet metal shield on piping requiring vapor barrier. Thermal conductivity of insulation to not exceed 0.30 at 75 degrees F. mean temperature.
   3. If hanger spacing exceeds 10 feet, use double layer shield on bearing surfaces.
   4. Piping 2½ in. and over: protection shield with foam glass insulation with uninterrupted vapor barrier between pipe and shield. [G167 / B3151, B3153]
   5. Piping 2½ in. and over: protective saddle with insulation between saddle and pipe (MSS SP-69, TYPE 39A/39B) [G160 - 166 / B3161 – B3165]
   6. Minimum shield lengths and sheet metal gauge to be as scheduled below.

Pipe Size	Minimum Length	Minimum Gauge
Up through 1 1/2-inch	4-inch	26
2-inch through 6-inch	6-inch	20
8-inch through 10-inch	9-inch	16

2.09 FINISHES AND COATINGS

A. Epoxy Coating/Isolation: Provide protective coating over surfaces of aluminum supports that bear against concrete, stainless steel, or as coatings are otherwise called out on drawings. Use high-solids, two component epoxy applied in not less than two coats to total dry film thickness of 12 mils minimum, 18 mils maximum. Manufacturer: Soc-Co Plastic Coating Company

B. Galvanized Plating: Provide custom fabricated metal supports and floor stands made from carbon steel stock. Hot dip galvanize after fabrication.

C. Dichromate Plating: Provide ONLY at indoor locations where piping is attached to walls or suspended from ceiling--not to be used for any floor mount locations. Stock metal strut and channel shapes with factory applied electrochromate finish. Finish to be dichromate over zinc by "Superstrut" Metal Framing Division, Midland-Ross Corporation, Goshen, IN (219) 533-0335; or approved substitute. Field cut ends to be finished with cold galvanizing corrosion resistant coating.

PART 3 - EXECUTION

3.01 APPLICATION

A. Provide nonmetallic supports with stainless steel hardware in interior corrosive areas. Provide 304 stainless steel supports with 304 stainless steel hardware in exterior corrosive areas. Use 316 stainless steel supports and hardware in and around salt water corrosive areas. Refer to drawings for corrosive areas.

B. When utilizing strut supports, solid strut shall be utilized in all areas where exposed to guest view. Slotted strut is acceptable in back of house areas.

3.02 INSTALLATION

A. Install supports to provide for free expansion of piping. Support piping from structure using concrete inserts, beam clamps, ceiling plates, wall brackets, or floor stands. Fasten ceiling plates and wall brackets securely to structure and test to demonstrate adequacy of fastening.

B. Coordinate hanger and support installation to permit grouping of piping supports.

3.03 HANGER AND SUPPORT SPACING

A. Space pipe hangers and supports in accordance with following tables, with exceptions as indicated herein:

		1		2		3		4		5	6	7	8	9	10	11	12	13
NOMINAL PIPE OR TUBE SIZE		STD WT STEEL PIPE				COPPER TUBE				CSST	DUCTILE IRON PIPE	CAST IRON SOIL	PEX	PLASTIC PVC	PLASTIC CPVC 1" (102 mm) AND SMALLER	PLASTIC CPVC 1-1/4" (31.6 mm) AND LARGER	PLASTIC PP 1" (102 mm) AND SMALLER	PLASTIC PP 1-1/4" (31.6 mm) AND LARGER
		WATER SERVICE		VAPOR SERVICE		WATER SERVICE		VAPOR SERVICE										
in.	mm	ft.	m	ft.	m	ft.	m	ft.	m									
1/4	(6)					5	1.5	4	1.2	FOLLOW REQUIREMENTS OF THE PIPING MANUFACTURER.	10 FT. (3.0m) MAX SPACING.	5 FT. (3.0m) MAX SPACING EXCEPT MAY INCREASE TO 10 FT. WHERE 10 FOOT LENGTHS ARE INSTALLED. MIN OF ONE (1) HANGER PER PIPE SECTION CLOSE TO JOINT ON THE BARREL. ALSO AT CHANGE OF DIRECTION AND BRANCH CONNECTIONS.	32 IN. (813mm) MAX. SPACING.	4 FT. (1.22m) MAX SPACING.	3 FT. (.91m) MAX. SPACING.	4 FT. (1.22m) MAX. SPACING.	32 IN. (813mm) MAX. SPACING.	4 FT. (1.22m) MAXIMUM SPACING.
3/8	(10)	7	2.1	6	1.8	5	1.5	4	1.2									
1/2	(15)	7	2.1	6	1.8	5	1.5	4	1.2									
3/4	(20)	7	2.1	8	2.4	5	1.5	6	1.8									
1	(25)	7	2.1	8	2.4	6	1.8	8	2.4									
1-1/4	(32)	7	2.1	10	3.0	6	2.1	8	2.4									
1-1/2	(40)	9	2.7	10	3.0	8	2.4	8	2.4									
2	(50)	10	3.0	10	3.0	8	2.4	8	2.4									
2-1/2	(65)	11	3.4	10	3.0	9	2.7	8	2.4									
3	(80)	12	3.7	10	3.0	10	3.0	8	2.4									
3-1/2	(90)	12	3.7	10	3.0	10	3.0	8	2.4									
4	(100)	12	3.7	10	3.0	10	3.0	8	2.4									
5	(125)	12	3.7	10	3.0	10	30	8	2.4									
6	(150)	12	3.7	10	3.0	10	3.0	8	2.4									
8	(200)	12	3.7	10	3.0	10	3.0	8	2.4									
10	(250)	12	3.7	10	3.0	10	3.0	8	2.4									
12	(300)	12	3.7	10	3.0	10	3.0	8	2.4									
14	(350)	12	3.7	10	3.0													
16	(400)	12	3.7	10	3.0													
18	(450)	12	3.7	10	3.0													
20	(500)	12	3.7	10	3.0													
24	(600)	12	3.7	10	3.0													
30	(750)	12	3.7	10	3.0													
Vertical Spacing		15	4.5	15	4.5	10	3.0	10	3.0	Per manufacturer	15'(4.5m)	15'(4.5m)	10'(3.0m)	10'(3.0m)	10'(3.0m)	10'(3.0m)	10'(3.0m)	10'(3.0m)

		COLUMNS(3) 1, 2, 6, 7		COLUMNS(3) 3, 4, 9, 10, 11, 12, 13	
NOMINAL PIPE OR TUBING SIZE		NOMINAL ROD DIA.		NOMINAL ROD DIA.	
in	mm	in	mm	in	mm
1/4	(6)			3/8	M10
3/8	(10)	3/8	M10	3/8	M10
1/2	(15)	3/8	M10	3/8	M10
3/4	(20)	3/8	M10	3/8	M10
1	(25)	3/8	M10	3/8	M10
1-1/4	(32)	3/8	M10	3/8	M10
1-1/2	(40)	3/8	M10	3/8	M10
2	(50)	3/8	M10	3/8	M10
2-1/2	(65)	1/2	M12	1/2	M12
3	(80)	1/2	M12	1/2	M12
3-1/2	(90)	1/2	M12	1/2	M12
4	(100)	5/8	M16	1/2	M12
5	(125)	5/8	M16	1/2	M12
6	(150)	3/4	M20	5/8	M16
8	(200)	3/4	M20	3/4	M20
10	(250)	7/8	M20	3/4	M20
12	(300)	7/8	M20	3/4	M20
14	(350)	1	M24		
16	(400)	1	M24		
18	(450)	1	M24		
20	(500)	1-1/4	M30		
24	(600)	1-1/4	M30		
30	(750)	1-1/4	M30		

NOTE:

(1) For calculated loads, rod diameters may be sized in accordance with MSS SP-58, Table 3 provided Table 1 and Section 7.3 of MSS SP-58 are satisfied.

(2) Rods may be reduced one size for double rod hangers. Minimum rod diameter shall be 3/8 in. (M10).

(3) Columns noted refer to Table 1, maximum horizontal pipe hanger and support spacing.

B. Place hangers to meet requirements of piping section of this specification, with regard to pitch for drainage and venting, and clearance between services. Visible deflection of piping systems will not be accepted.

C. Place hangers within one foot of each elbow. Place hangers at each valve and strainer for piping 4" and above.

3.04 SPRING HANGERS AND SUPPORTS

A. Hangers for piping connected in conjunction with rotating or reciprocating equipment to be combination spring and neoprene hangers for distance of 100-pipe diameters, or distance of three hangers away from rotating or reciprocating equipment whichever is greater. Isolators to be as specified under Section 15550 - Vibration Isolation.

B. Horizontal piping supported from floor which is connected in conjunction with rotating or reciprocating equipment to have spring and neoprene isolators for distance of one hundred pipe diameters or distance of three support points from equipment whichever is greater.

3.05 RISER SUPPORTS

A. Support vertical piping with clamps secured to piping and resting on building structure.

B. Piping 5" and above, of lengths exceeding 30 feet, to be additionally supported on base elbows secured to building structure, with flexible supporting hangers, provided at top of riser to allow for pipe expansion.

3.06 THERMAL PIPE SHIELDS

A. Install thermal pipe shields at support points for insulated piping.

B. Spacing shall be per hanger spacing. Shield length and thickness shall be per ANSI/MSS Sp.69 Table 5.

3.07 CONTINUOUS INSERT CHANNELS

A. Mount continuous insert channels when used for pipe support on 8-foot maximum centers and 2 foot from corners.

END OF SECTION

SECTION 220549

SEISMIC RESTRAINT FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 specifications, apply to this section.

1.02 SUMMARY

A. Related Requirements:
   1. Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment” for commonly used supports and installation requirements.

1.03 DEFINITIONS

A. ASCE: American Society of Civil Engineers.

B. IBC: International Building Code.

1.04 PERFORMANCE REQUIREMENTS

A. Equipment Design supports, attachments, and restraints according to IBC and ASCE 7-05 as Delegated-Design.

B. Select support, attachment, and restraint details complying with requirements of IBC and ASCE 7-05 from one of the following OSHPD Pre-Approvals:
   1. Cooper B-Line (OPA-0114).
   2. SMACNA (OPA-0010).
   3. Mason Industries (OPA-0349).
   4. ISAT (OPA-0485).

C. Use seismic design values shown on structural drawings.

D. Treat components that are part of life safety / emergency systems as having Component Importance Factor = 1.5. Treat other components as having Component Importance Factor = 1.5 if so scheduled on the drawings.

1.05 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For seismic restraint details governed by performance requirements, include analysis data signed and sealed by a professional engineer responsible for their preparation who is qualified for such work in the place of the project.
   1. Design Calculations: Calculate loading due to equipment weight, operation, and seismic forces required to select seismic restraints.
      a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors.
   2. Include materials and dimensions and identify hardware, including attachment and anchorage devices, for equipment and for manufactured and field fabricated supports.
   3. Seismic Restraint Details:
      a. Design Analysis: Support selection and arrangement of seismic restraints.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Identify components, Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices, where applicable.

c. Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

B. Coordination Drawings: Show proposed locations of supports and restraints for distribution system components.
   1. Show coordination of seismic bracing for plumbing components with other systems and equipment in the vicinity, including other supports and seismic restraints.

1.06 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.01 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide products of Mason Industries or a comparable product by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Hilti Inc.
   3. Loos & Co.; Seismic Earthquake Division.
   4. Mason Industries.
   5. ISAT.
   6. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components:
   1. Components used in OSHPD Pre-Approval details: Use products according to OSHPD Pre-Approval details selected for this project.

2.02 FACTORY FINISHES

A. Finish: Manufacturer's standard paint or galvanized.
   1. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive seismic restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing in of reinforcement and cast-in-place anchors to verify actual location before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATION

A. Multiple pipe supports: Secure piping to trapeze members with clamps approved for application by an agency acceptable to authorities having jurisdiction.

3.03 SEISMIC RESTRAINT DEVICE INSTALLATION

A. Install seismic restraint devices for distribution components according to OSHPD Pre-Approval details.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections: Test and inspect to meet regulatory requirements.

END OF SECTION

SECTION 220553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 QUALITY ASSURANCE

A. All tags and labels for medical gas piping systems shall be in accordance to NFPA 99.

1.03 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black. Red shall be used if the equipment is on emergency power.
   4. Maximum Temperature: Able to withstand temperatures of up to 160°F .
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 1-1/2 inch.
   6. Minimum Letter Size: 1/2 inch. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Fasteners: Stainless-steel rivets or self-tapping screws.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11-inch (A4) bond paper, tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules). Equipment schedule shall be included in operation and maintenance data.

2.02 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

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 2-1/2 inches high.
   3. Colors: Conform to ASHA/ANSI standards as manufactured by Seton.

2.03 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4 inch letters for piping system abbreviation and 1/2 inch numbers. Valves shall be tagged per the chart below.

PIPING	VALVES
Cold Water	CW-1, CW-2, CW-3, etc.
Hot Water (Domestic)	HW-1, HW-2, HW-3, etc.
Hot Water Return (Domestic)	HR-1, HR-2, HR-3, etc.
Gas	GAS-1, GAS-2, GAS-3, etc.
Storm	N/A

1. Tag Material: Brass, 0.032-inch minimum thickness, 1-1/2-inch minimum dimmer and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain, or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch (A4) bond paper, tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.
2. Furnish a typewritten framed chart under glass indicating fixtures or areas supplied by each number valve and mount same as directed by Owner or Architect.

C. Ceiling Identification: Provide color coded dots on accessible ceiling grid to identify the location of valves mounted above the ceiling.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten label on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. All backflow preventers, vacuum breakers, mixing valves, hose stations, and primer manifolds shall also be labeled.

3.03 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. At least once in each room.
8. At each location where exposed piping passes through walls and floors.

3.04 VALVE-TAG INSTALLATION

A. Install tags on all valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; equipment shut-off valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units.

END OF SECTION

SECTION 221116

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
   2. Specialty valves.
   3. Flexible connectors.
   4. Escutcheons.
   5. Sleeves and sleeve seals.
   6. Wall penetration systems.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions.

1.04 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.

B. Water Samples: Specified in "Cleaning" Article.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Domestic water piping.
   2. Compressed air piping.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic, potable domestic water piping and components.

C. Comply with NSF 61 for potable domestic water piping and components.

1.06 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 Owner no fewer than three days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without Owner's written permission.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
   1. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
   3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
   4. Copper-Tube Extruded-Tee Connections:
      a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
         1) T-DRILL Industries Inc.
      b. Description: Tee formed in copper tube according to ASTM F 2014.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
   1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.03 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. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.04 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      b. Zurn Plumbing Products Group; Wilkins Water Control Products.
   2. Description:
      a. Pressure Rating: 250 psig at 180 deg F.
      b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Central Plastics Company.
      b. EPCO Sales, Inc.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Factory-fabricated, bolted, companion-flange assembly.
      b. Pressure Rating: 300 psig.

2.05 COPPER PIPE SLEEVE

A. Material: 10 mil polyethylene sleeve for protection in concrete pour.
   1. Piping shall be cleaned prior to installation. Extend sleeve 6” above the floor level. Tape ends shut to prevent entry of debris between piping and sleeve. Sleeve shall be installed on all copper piping passing through concrete floors and walls.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

F. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install piping to permit valve servicing.

H. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

I. All underground piping outside and inside the building shall be laid supported on 3" compacted bedding of sand, gravel, or crushed stone of which 100% will pass through 1/2" sieve. The bedding shall be shaped for clearance for all joints and fittings, and tamped in place, graded evenly to insure uniform bearing for the full length of the bottom quadrant of pipe. No piping shall be supported by blocking, planking or mounding of bedding material.
   1. Should the trench be over excavated, follow the above procedure in layers a maximum of 6” deep compacting after each layer.
   2. Should rock be encountered during trenching, the rock shall be removed to a minimum of 3” below the pipe placement and backfilled with bedding as described above, compacting to provide uniform load-bearing support. The pipe shall not rest on rock at any point.
   3. Should soft or poor load-bearing material be found during trenching, the trench shall be over excavated a minimum of two pipe diameters, backfilled to the level of the bottom of the pipe with fine gravel, crushed stone or a concrete foundation with a sand bedding tamped to provide uniform loading.
   4. As an option, if allowed by the AHJ, all underground piping outside and inside the building shall be laid on undisturbed compacted soil, eliminating the need for bedding.
   5. Trench backfilling shall utilize loose earth free from rocks, debris, and construction material. The backfill shall be placed in 6” increments tamped in place to provide support for the piping. Backfill shall cover the piping a minimum of 12”.

3.03 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

G. 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.

3.04 VALVE INSTALLATION

A. 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.

B. Install drain valves for equipment at base of each water riser, 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.

3.05 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

3.07 IDENTIFICATION

A. Identify system components.

B. Label pressure piping with system operating pressure.

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. 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.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

C. Prepare test and inspection reports.

3.09 ADJUSTING

A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.

3.10 CLEANING

A. Clean and disinfect 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 procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction, should it be mandated by them. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

B. Under-building-slab, domestic water, building service piping, NPS 4 and smaller, shall be the following:
1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

C. Aboveground domestic water piping, NPS 6 and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; wrought- copper solder-joint fittings; and soldered joints.

END OF SECTION

SECTION 221119

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following domestic water piping specialties:
   1. Backflow preventers.
   2. Hose bibbs.
   3. Wall hydrants.
   4. Trap-seal primer valves.

B. Related Sections include the following:
   1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.

1.02 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.03 SUBMITTALS

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

B. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. NSF Compliance:
   1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
   2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.01 VACUUM BREAKERS

A. Hose-Connection Vacuum Breakers shall meet ASSE 1011:
   1. Manufacturers: Watts Industries, Woodford, Wilkins.

2.02 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers shall meet ASSE 1013:
   1. Manufacturers: FEBCO, Watts Industries, Wilkins.

2.03 HOSE BIBBS

A. Hose Bibbs shall meet ASME A112.18.1 for sediment faucets as manufactured by Zurn, Woodford, Jay R Smith..

2.04 WALL HYDRANTS

A. Nonfreeze Wall Hydrants shall meet ASME A112.21.3M for self-draining wall hydrants:
   1. Manufacturers: Jay R. Smith, Woodford, Zurn.

B. Vacuum Breaker Wall Hydrants shall meet ASSE 1019, Type A or Type B:
   1. Manufacturers: Jay R. Smith, Watts, Woodford, Zurn.

2.05 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:
   1. Manufacturers: PPP Inc, Sioux Chief, Jay R Smith, Watts, Zurn.
   2. Standard: ASSE 1018.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer.

3.02 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each vacuum breaker and backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

END OF SECTION

SECTION 221316

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes the following for soil, waste, vent and indirect waste piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

B. Related Sections include the following:
   1. Division 22 Section “General Duty Valves for Plumbing”
   2. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
   3. Division 22 Section “Sanitary Waste Piping Specialties

1.03 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.
   2. Sanitary Sewer Force-Main Piping: 100 psig.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events.

1.04 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Cast-Iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Pipe Institute.

C. 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; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service, class, CISPI 301.
   1. Manufacturers:
      a. AB&I Foundry
      b. CHARLOTTE Pipe and Foundry Company
      c. Tyler Pipe

B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888/CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
   1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
      a. Manufacturers:
         1) ANACO.
         2) Ideal Div.; Stant Corp.
         3) Mission Rubber Co.
         4) Tyler Pipe; Soil Pipe Div.
   2. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
      a. Manufacturers:
         1) ANACO (HUSKY).
         2) Clamp-All Corp.
         3) Ideal Div.; Stant Corp.
         4) Mission Rubber Co.,
         5) Charlotte Pipe.

2.04 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
   1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
   1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.05 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
   1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. Solvent Cement and Adhesive Primer: ASTM D-2564
   1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping shall be any of the following:
   1. Hubless cast-iron soil pipe and fittings; stainless-steel couplings; and hubless-coupling joints.
   2. Copper DWV tube, copper drainage fittings, and soldered joints.
   3. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Aboveground, vent piping shall be any of the following:
   1. Hubless cast-iron soil pipe and fittings; standard, shielded, stainless-steel couplings; and hubless-coupling joints.
   2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Underground, soil, waste, and vent piping shall be the following:
   1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

E. Aboveground sanitary-sewage force mains shall be any of the following:
   1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
   2. Galvanized steel pipe, pressure fittings, and threaded joints.
   3. Schedule 80 PVC pipe and fittings.

F. Underground sanitary-sewage force mains shall be the following
   1. Solid wall PVC pipe pressure pipe, PVC socket fittings, and solvent-cemented joints.

G. Indirect Waste piping NPS 1 1/4 and larger shall be any of the following:
   1. Hard copper tube, Type M; copper pressure fittings; and soldered joints.
   2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. (Not allowed in kitchen, food service areas.)

3.02 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 21 Section "Facility Sanitary Sewers."

B. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 21 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall.

F. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

G. 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.

H. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

J. All underground piping outside and inside the building shall be laid supported on 3" compacted bedding of sand, gravel, or crushed stone of which 100% will pass through 1/2" sieve. The bedding shall be shaped for clearance for all joints and fittings, and tamped in place, graded evenly to insure uniform bearing for the full length of the bottom quadrant of pipe. No piping shall be supported by blocking, planking or mounding of bedding material.
   1. Should the trench be over excavated, follow the above procedure in layers a maximum of 6” deep compacting after each layer.
   2. Should rock be encountered during trenching, the rock shall be removed to a minimum of 3” below the pipe placement and backfilled with bedding as described above, compacting to provide uniform load-bearing support. The pipe shall not rest on rock at any point.

3. Should soft or poor load-bearing material be found during trenching, the trench shall be over excavated a minimum of two pipe diameters, backfilled to the level of the bottom of the pipe with fine gravel, crushed stone or a concrete foundation with a sand bedding tamped to provide uniform loading.
4. As an option, if allowed by the AHJ, all underground piping outside and inside the building shall be laid on undisturbed compacted soil, eliminating the need for bedding.
5. Trench backfilling shall utilize loose earth free from rocks, debris, and construction material. The backfill shall be placed in 6” increments tamped in place to provide support for the piping. Backfill shall cover the piping a minimum of 12”.

K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

D. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.04 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.05 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior to complete sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Verify all invert elevations and measurements prior to the installation of materials, either underground, above ground, or in the building.

D. Install underground lines passing under foundations with minimum of 6" clearance to concrete and insure there is no disturbance of bearing soil.

E. Above slab sanitary and vent piping shall be supported from the building structure. Under no circumstances shall piping be supported from equipment, piping or conduits within the building structure.

F. All floor drains shall be set true and level and shall be protected properly throughout entire construction. Weep holes shall be filled with removable material, and kept free from concrete and other debris during construction. Weep holes shall be cleaned out for final working order. Safe with lead as specified. Resealing prime connections are required on all floor drains except floor drains located in showers.

G. Trap each fixture and piece of equipment requiring drainage connections. Trap seals shall be 4” deep seal type. Traps shall be set true and level and located within the limits of the code requirements.

H. Provide plugs or caps for all opening during the construction phase. The temporary plug shall be plastic cap or equivalent. Duct tape is unacceptable for use as a plug.

I. All vents through roof shall be installed a minimum of 10'-0" from all fresh air intake to air handling equipment and offset minimum of 3'-0" from edge of roof lines, parapets and all other flashing. Vent piping shall be collected so roof will be pierced a minimum number of times.

J. Contractor shall coordinate with General Contractor to ensure floor drains are level with finished floor and finished floor is sloped in all directions toward floor drain.

K. Plastic piping shall not be used in plenum spaces unless UL listed for this application and approval is given by the AHJ.

3.06 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
   1. 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.

D. Test force-main piping according to procedures as follows:
   1. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   2. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

3.07 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 using pre-manufactured end caps.

3.08 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION

SECTION 221319

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor and trench drains.
   3. Miscellaneous sanitary drainage piping specialties.

1.02 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 CLEANOUTS

A. Exterior Cast-Iron Cleanouts (ECO):
   1. Manufacturers: Josam, Jay R Smith, Watts, Zurn.
   2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   3. Body Material: cast-iron as required to match connected piping.
   4. Closure: Countersunk, tapered threaded bronze plug, with heavy duty scoriated loose set, round cast iron tractor cover.
   5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
   6. Cleanout shall be equal to Zurn Z1402-NL-BP-HD

B. Cast-Iron Floor Cleanouts (FCO):
   1. Manufacturers: Josam, Jay R Smith, Watts, Zurn.
   2. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
   3. Body Material: Cast iron.
   4. Closure: Gas and watertight bronze plug with tapered threads with round scoriated secured top.
   5. Adjustable Housing Material: Cast iron with threads.
   6. Frame and Cover Material and Finish: Nickel-bronze.
   7. Riser: Service class, cast-iron drainage pipe fitting and riser to cleanout.
   8. Cleanout shall be equal to Zurn ZN1400-NL-BP.

C. Cast-Iron Wall Cleanouts (WCO):
   1. Manufacturers: Josam, Jay R Smith, Watts, Zurn.
   2. Standard: ASME A112.36.2M. Include wall access.
   3. Size: Same as connected drainage piping.
   4. Body: cast-iron as required to match connected piping.
   5. Closure: drilled-and-threaded bronze plug.
   6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
   7. Wall Access: Round, flat, stainless-steel cover plate with screw.
   8. Cleanout shall be equal to Zurn Z1441-BP.

2.02 FLOOR AND TRENCH DRAINS

A. Cast-Iron Floor Drains (Refer to Floor Drain Schedule on drawings for identification):
   1. Manufacturers: Josam, Jay R Smith, Watts, Zurn.
   2. Standard: ASME A112.6.3.

2.03 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 100 feet.
   4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor.
   1. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
   2. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

E. Install air-gap fittings on indirect-waste piping discharge into sanitary drainage system.

F. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

END OF SECTION

SECTION 221413

FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes the following storm drainage piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.

B. Related Sections include the following:
   1. Division 22 Section "Sump Pumps."
   2. Division 22 Section “General Duty Valves for Plumbing”
   3. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
   4. Division 22 Section “Sanitary Waste Piping Specialties

1.03 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water.
   2. Storm Drainage, Force-Main Piping: 100 psig.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events.

1.04 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Cast-Iron pipe and fittings shall be marked with the collective trademark of the Cast Iron Pipe Institute.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.
   1. Manufacturers:
      a. AB&I Foundry

b. CHARLOTTE Pipe and Foundry Company
c. Tyler Pipe

B. Gaskets: ASTM C 564, rubber.

2.04 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888/CISPI 301.

B. Shielded Couplings: Assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
1. Standard, Shielded, Stainless-Steel Couplings: CISPI 310, marked with NSF, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve.
a. Manufacturers:
1) Anaco-Husky
2) Ideal
3) Fernco
4) Mission Rubber Co.
5) Tyler Pipe; Soil Pipe Div.
6) Clamp-All 80
2. Medium-Duty, Shielded, Stainless-Steel Couplings: ASTM C1540, with stainless-steel shield, stainless-steel bands and tightening devices 5/16” hex head screws, and ASTM C 564, rubber sleeve.
a. Manufacturers:
1) Anaco-Husky HD-2000
2) Ideal Heavy Duty MD
3) Fernco Medium Duty
4) Mission Rubber Co. Heavy Weight
5) Tyler Pipe; Soil Pipe Div.
6) Clamp-All 125
3. Heavy-Duty, Shielded, Stainless-Steel Couplings: ASTM C1540, with stainless-steel shield, stainless-steel bands and tightening devices utilizing 3/8” hex head screws, and ASTM C 564, rubber sleeve.
a. Manufacturers:
1) Anaco-Husky SD-4000
2) Ideal Heavy Duty HD
3) Fernco Heavy Duty

2.05 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.

B. Solvent Cement and Adhesive Primer: ASTM D-2564

2.06 SPECIAL PIPE FITTINGS

A. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
1. Manufacturers:
a. EBAA Iron Sales, Inc.
b. Romac Industries, Inc.

PART 3 - EXECUTION

3.01 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground storm drainage piping shall be [any of] the following:
   1. Hubless cast-iron soil pipe and fittings; [standard][heavy-duty] shielded, stainless-steel couplings; and hubless-coupling joints.
   2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

C. Underground storm drainage piping shall be the following:
   1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

D. Aboveground storm drainage force mains shall be [any of] the following:
   1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
   2. Galvanized steel pipe, pressure fittings, and threaded joints.
   3. Schedule 80 PVC pipe and fittings.

E. Underground storm drainage force mains shall be the following:
   1. Solid wall PVC pipe, PVC socket fitting and solvent-cemented joint.

3.03 PIPING INSTALLATION

A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.

D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall.

E. Make changes in direction for storm drainage 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. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

G. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

H. All underground piping outside and inside the building shall be laid supported on 3" compacted bedding of sand, gravel, or crushed stone of which 100% will pass through 1/2" sieve. The bedding shall be shaped for clearance for all joints and fittings, and tamped in place, graded evenly to insure uniform bearing for the full length of the bottom quadrant of pipe. No piping shall be supported by blocking, planking or mounding of bedding material.
   1. Should the trench be over excavated, follow the above procedure in layers a maximum of 6” deep compacting after each layer.
   2. Should rock be encountered during trenching, the rock shall be removed to a minimum of 3” below the pipe placement and backfilled with bedding as described above, compacting to provide uniform load-bearing support. The pipe shall not rest on rock at any point.

3. Should soft or poor load-bearing material be found during trenching, the trench shall be over excavated a minimum of two pipe diameters, backfilled to the level of the bottom of the pipe with fine gravel, crushed stone or a concrete foundation with a sand bedding tamped to provide uniform loading.
4. As an option, if allowed by the AHJ, all underground piping outside and inside the building shall be laid on undisturbed compacted soil, eliminating the need for bedding.
5. Trench backfilling shall utilize loose earth free from rocks, debris, and construction material. The backfill shall be placed in 6” increments tamped in place to provide support for the piping. Backfill shall cover the piping a minimum of 12”.

I. Install PVC storm drainage piping according to ASTM D 2665.

3.04 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.05 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect piping to exterior piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

D. Provide plugs or caps for all opening during the construction phase. The temporary plug shall be plastic cap or equivalent. Duct tape is unacceptable for use as a plug, support or to separate ferrous from non-ferrous materials for the construction phase.

E. Contractor shall coordinate with General Contractor to ensure area drains are level with finished floor and finished floor is sloped in all directions toward area drain.

F. Plastic piping shall not be used in plenum spaces unless UL listed for this application and approval is given by the AHJ.

3.07 FIELD QUALITY CONTROL

A. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test Procedure: Test storm drainage piping, except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
2. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
3. Prepare reports for tests and required corrective action.

B. Test force-main piping according to procedures:

1. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
2. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

3.08 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 using pre-manufactured end caps.

END OF SECTION

SECTION 221423

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following storm drainage piping specialties:
   1. Roof drains.
   2. Miscellaneous storm drainage piping specialties.

1.02 SUBMITTALS

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

1.03 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 CLEANOUTS

A. All cleanouts shall be equal to those specified in the Division 22 Section “Sanitary Waste Piping Specialties”.

2.02 ROOF DRAINS

A. Cast-Iron Roof Drains (Refer to Drain Schedule on drawings for identification):
   1. Manufacturers: Josam, Jay R Smith, Wade, Watts, Zurn.
   2. Standard: ASME A112.21.2M.
   3. If a manufacturer other than that specified is submitted, all options specified on the drawings shall be provided on the submitted roof drain.

2.03 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Boots:
   1. Description: ASTM A 74, Service class, hub-and-spigot, cast-iron soil pipe.
   2. Size: Same as or larger than connected downspout.

B. Downspout Nozzles:
   1. Description: Nickel bronze body with threaded or no-hub inlet and decorative bronze wall flange and nozzle. Downspout nozzle shall be provided with removable stainless steel screen.
   2. Size: Same as connected rain leader.
      a. Manufacturer: Zurn #ZANB199-SS

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install roof drains at low points of roof areas according to roof manufacturer's written installation instructions.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

B. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

C. Install cast-iron soil pipe downspout boots at grade with top of hub 12 inches above grade.

D. Install downspout nozzles at exposed bottom of rain leaders to spill 12” above grade.

3.02 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 221513

GENERAL-SERVICES COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes piping and related specialties for general-service compressed-air systems operating up to 200 psig or less.

B. Related Sections include the following:
   1. Division 22 Section "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.02 SUBMITTALS

A. Product Data: For the following:
   1. Piping, fittings, and valves.
   2. Flexible pipe connectors.
   3. Safety valves.
   4. Pressure regulators. Include rated capacities and operating characteristics.
   5. Automatic drain valves.
   6. Filters. Include rated capacities and operating characteristics.
   7. Quick couplings.
   8. Hose assemblies.

B. Operation and Maintenance Data: For general-service compressed-air piping specialties to include maintenance manuals.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Copper Tube: ASTM B 88, Type Lseamless, drawn-temper, water tube.
   1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
   2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
   3. Copper Unions: ASME B16.22 or MSS SP-123.

B. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. HDPE Piping System: Made of ASTM D 1248, HDPE resin to provide shatter-resistant pipe for compressed-air service. Pipe and fittings are dark blue with pipe dimensions about the same OD as ASTM D 3035, PE pipe as manufactured by Asahi/America.
   1. Transition Fittings, NPS 1/2 to NPS 2 : HDPE adapter with one socket end and one end with threaded brass insert.
   2. Transition Fittings, NPS 2-1/2 to NPS 4: HDPE flange, CR gasket, and metal flange of material matching piping to be connected.

D. Aluminum Piping System: Rigid aluminum 6063 T5 piping system complying with ASME B31.3 and B31.1. It shall be recyclable and be full bore passage without diameter restrictions for the fittings. The aluminum shall be powder coated. The smaller pipe sizes shall be rated for a temperature and pressure range of 232 PSI from -4 degrees F to 140 degrees Fwith the 168mm rated at 175 PSI from -4 degrees F to 140 degrees F. The piping shall be compatible to all compressor mineral and synthetic oils. System shall be equal to that manufactured by Parker Legris Transair.

1. All 16.5 mm, 25 mm and 40 mm connectors shall be instant-to-connect using a gripping ring technology with ahalf turn release nut mechanism. They shall incorporate a lateral dismantling feature for the rigid pipe and the fittings. The connectors* shall be manufactured in engineering grade plastic (PA 6.6 or PA 12 + 30% glass fiber reinforced) with gripping teeth manufactured in stainless steel Z10 CN 17-7E2 and with seals of nitrile IRHD50.
2. All 63 mm connectors shall be instant to connect using a double clamp ring technology with a threaded release nut mechanism. They shall provide a lateral dismantling feature for the rigid pipe. The connectors* shall be manufactured in black cataphoresis aluminum AS9U3 with a clamp ring manufactured in aluminum AS9U3 and with seals of nitrile IRHD70.
3. All OD 76mm and OD 101mm fittings shall be formed from 304 Stainless Steel and conform to ASTM A774 specifications. All fittings shall be connected using clamp and cartridge technology with a reusable mechanical connection. The clamp shall be manufactured of Zinc treated steel with the cartridge manufactured in engineering grade polymer with seals of nitrile IRHD50.
4. All OD 168mm fittings shall be formed from cast aluminum and conform to ASME B31 specifications. All fittings shall be connected using clamp and cartridge technology with a reusable mechanical connection. The clamp shall be manufactured of cast aluminum with the cartridge manufactured in engineering grade polymer with seals of nitrile IRHD50.

E. PE-AL-PE Piping System: High density polyethylene (HDPE) and aluminum pressure pipe conforming to ASTM F1282 and CSA B137.9. PE-AL-PE shall conform to the safety requirements of OSHA. Inner and outer HDPE shall be of Grade PE33 per ASTM D3350 and have a hydrostatic design stress of 630 psi at 73 degrees F. The outer HDPE layer shall include UV stabilizer. Inner Pipe layer shall be resistant to commonly used synthetic and natural compressor oils. Product shall be IPEX Duratec
   1. Brass Fittings: Brass fittings shall meet the requirements of ASTM F1974 and CSA B137.9. Fittings shall have a protective nickel plating to provide resistance to corrosive industrial environments.
   2. Stainless Steel Fittings: Stainless steel fittings shall meet the dimensional and performance requirements of ASTM F1974 and CSA B137.9, and shall be made with UNS S31600 stainless steel.

F. Compressed Air Hose: Tube – Black nitrile; ARPM Class A oil resistance, Cover – Red Chloroprene, Reinforcement is polyester fiber, 300 PSI working pressure. Product shall be Parker series #7094.

2.02 PIPING JOINING MATERIALS

A. Refer to Division 22 for materials common to multiple specification sections.

2.03 VALVES

A. Metal Ball, Butterfly, Check, and Globe Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping."

2.04 FLEXIBLE PIPE CONNECTORS

A. Manufacturers:
   1. Flexicraft Industries.
   2. Mercer Rubber Co.
   3. Metraflex, Inc.

B. Stainless-Steel-Hose Flexible Pipe Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: 250 psig minimum.
   2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.
   3. End Connections, NPS 2-1/2and Larger: Flanged steel nipple.

2.05 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.
   1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Air-Main Pressure Regulators: Bronze body, pilot operated, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 250-psiginlet pressure.

C. Air-Line Pressure Regulators: Diaphragm or pilot operated, bronze body, direct acting, spring-loaded manual pressure-setting adjustment, and rated for 200-psig minimum inlet pressure, unless otherwise indicated.

D. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

E. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated.

F. Mechanical Filters: Two-stage, mechanical-separation-type, air-line filters. Equip with deflector plates, resin-impregnated-ribbon-type filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated.

2.06 QUICK COUPLINGS

A. Manufacturers:
   1. Aeroquip Corporation; Eaton Corp.
   2. Parker Hannifin Corp.; Fluid Connectors Group; Quick Coupling Div.
   3. Schrader-Bridgeport.
   4. Snap-Tite, Inc.; Quick Disconnect & Valve Division.
   5. TOMCO Products Inc.

B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

C. Automatic-Shutoff Quick Couplings: Straight-through brass body with O-ring or gasket seal and stainless-steel or nickel-plated-steel operating parts.
   1. Socket End: With one-way valve and threaded inlet for connection to piping or threaded hose fitting.
   2. Plug End: Straight-through type with barbed outlet for attaching hose.

D. Valve-less Quick Couplings: Straight-through brass body with stainless-steel or nickel-plated-steel operating parts.
   1. Socket End: With O-ring or gasket seal, without valve, and with barbed inlet for attaching hose.
   2. Plug End: With barbed outlet for attaching hose.

2.07 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300-psigminimum working pressure, unless otherwise indicated.
   1. Hose: Reinforced single- or double-wire-braid, CR-covered hose for compressed-air service.
   2. Hose Clamps: Stainless-steel clamps or bands.
   3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless-steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.

4. Hose Splicers: One-piece, straight-through brass or stainless-steel fitting with barbed ends for connecting two sections of hose.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

A. Compressed-Air Piping between Air Compressors and Receivers: Use one of the following piping materials:
   1. Type L, copper tube.

B. Below Grade Compressed-Air Distribution Piping: Use one of the following piping materials:
   1. PE-AL-PE piping system
   2. HDPE pipe, fittings, and valves; and heat-fusion joints.
   3. Compressed air hose placed in PVC conduit.

C. Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:
   1. Type L, copper tube.
   2. Aluminum piping system

D. Drain Piping: Use the following piping materials:
   1. Type L copper tube; wrought-copper fittings; and brazed or soldered joints.

3.02 VALVE APPLICATIONS

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for metal general-duty valves. Use metal valves, unless otherwise indicated.
   1. Metal General-Duty Valves: Use valve types specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
   2. Plastic General-Duty Valves: Provide valves, made by piping manufacturer, that are compatible with piping. Do not use plastic valves between air compressors and receivers.
      a. HDPE Piping System: Ball valves.

3.03 PIPING INSTALLATION

A. Install air and drain piping with 1 percent slope downward in direction of flow.

B. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating, unless otherwise indicated.

C. Equipment and Specialty Flanged Connections:
   1. Use steel companion flange with gasket for connection to steel pipe.
   2. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

D. Flanged joints may be used instead of specified joint for any piping or tubing system.

E. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, according to Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F 2014.

F. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

G. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

H. Install pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

I. Install piping per the manufacturer's recommendations.

3.04 JOINT CONSTRUCTION

A. Refer to Division 22 Sections for installation common to multiple specification sections.

B. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

C. Heat-Fusion Joints for PE Piping: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 for socket-fusion joints.

D. Use dielectric fittings when joining dissimilar metal piping materials.

E. Install fittings per the manufacturer's recommendations.

3.05 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" and per the manufacturer's recommendations.

B. Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.

C. Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.

D. Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

3.06 FLEXIBLE PIPE CONNECTOR INSTALLATION

A. Install flexible pipe connectors in discharge piping of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless-steel-hose flexible pipe connectors in steel compressed-air piping.

3.07 SPECIALTY INSTALLATION

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment and tools.

D. Install automatic drain valves on aftercoolers, receivers, and dryers. Discharge condensate onto nearest floor drain.

E. Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters. Mount on wall at locations indicated.

F. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.

G. Install quick couplings at piping terminals for hose connections.

H. Install hose assemblies at hose connections.

3.08 CLEANING AND PURGING

A. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

B. Flush piping system with clean, dry air or nitrogen until all outlets have no moisture or dirt present in the air stream.
   1. System shall be purged with multiple outlets flowing simultaneously to achieve a high volume flow rate.

2. Purge shall be started with the outlet closest to the compressor, finishing with the outlet furthest from the compressor.
3. No discoloration on a white cloth shall be present at the end of the purge.
4. No moisture shall be present from any outlet at the end of the purge.

3.09 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:
1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Piping Leak Tests for HDPE and PE-AL-PE Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen, at temperature of 100 deg F or less, to pressure of 40 psig above system operating pressure, but not less than 150 psig or more than 180 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
3. Repair leaks and retest until no leaks exist.

END OF SECTION

SECTION 221519

GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Lubricated, reciprocating air compressors.

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressed-air equipment shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces.

1.3 SUBMITTALS

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

B. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Entire air compressor package shall have UL assembly listing.

B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 LUBRICATED, RECIPROCATING AIR COMPRESSORS

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:

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Atlas Copco.
   2. Ingersoll-Rand; Air Solutions Group.
   3. Kaeser Compressors, Inc.
   4. Quincy Compressor; an EnPro Industries company.
   5. Saylor-Beall Manufacturing Company.

C. Compressor(s): Lubricated, reciprocating-piston type with lubricated compression chamber and crankcase.
   1. Submerged gear-type oil pump.
   2. Oil filter.
   3. Combined high discharge-air temperature and low lubrication-oil pressure switch.
   4. Belt guard totally enclosing pulleys and belts.

D. Capacities and Characteristics:
   1. Refer to Drawings.

2.2 INLET-AIR FILTERS

A. Description: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Equipment Mounting: Install air compressors on concrete bases using elastomeric pads. Comply with requirements in Division 03 Section " Miscellaneous Cast-in-Place Concrete." Comply with requirements for vibration isolation devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
   1. Minimum Deflection: 1/4 inch.

B. Install the following devices on compressed-air equipment:
   1. Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
   2. Pressure Regulators: Install downstream from air compressors and dryers.
   3. Automatic Drain Valves: Install on receivers, and dryers. Discharge condensate over nearest floor drain.

C. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

3.3 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

END OF SECTION

SECTION 224500

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following emergency plumbing fixtures:
   1. Eyewash equipment.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include flow rates and capacities, materials, furnished specialties, and accessories.

1.03 QUALITY ASSURANCE

A. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" for plumbing fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

PART 2 - PRODUCTS

2.01 FIXTURES

A. All fixtures basis of design is listed on the drawings. The following manufacturers are subject to compliance with the requirements listed on the drawings.
   1. Eyewash equipment: Encon, Guardian, Haws, Speakman.

2.02 EYE/FACE WASH EQUIPMENT

A. Description: Plumbed, freestanding, pedestal eye/face wash equipment.
   1. Capacity: Deliver potable water at rate not less than 3.0 gpm for at least 15 minutes.
   2. Control-Valve Actuator: Push bar.
   3. Receptor: bowl.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures. Use ball valve if specific type valve is not indicated. Install valves chained or locked in open position. Install valves in locations where they can easily be reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

E. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 22 Section "Common Work Results for Plumbing."

F. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.

G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

H. Adjust or replace fixture flow regulators for proper flow.

END OF SECTION

SECTION 230500

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Grout.
   2. Flashing materials.
   3. Access panels
   4. Equipment installation requirements common to equipment sections.
   5. Painting and finishing.
   6. Concrete bases.
   7. Supports and anchorages.

1.03 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.

1.04 SCOPE

A. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work may not be specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

B. It is the intent that these Specifications and associated Drawings establish minimum requirements for products and equipment with the intent to provide HVAC systems finished, tested and ready for operation. Incidental detail that is not shown or specified, but necessary for proper installation and operation shall be included in the work and in these Contractor's estimates, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each pipe, duct and piece of equipment to minimize conflicts with other trades.

C. This project will be phased, as defined by the Owner. This may necessitate the provision of temporary valving and capping of existing utilities or HVAC systems. All associated

appurtenances with the utilities shall be provided as part of this project in the appropriate phase coordinated with Owner's phasing requirements.

D. It is the requirement of these Contract Documents to have the contractors provide systems and components that are fully complete, operational and suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the Contractor has failed to notify the Architect of the situation the Contractor shall include the specific components or subsystems with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

1.05 MODIFICATIONS IN LAYOUT

A. Drawings are intended to outline the scope of work required and are not intended to be installation drawings. Drawings are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component nor do they show the exact routing and locations needed to coordinate with structure and other trades and to meet Architectural requirements. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

B. Unless specifically stated to the contrary, no measurement of a drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

C. Prior to installation of visible material and equipment (including access panels) in finished spaces, review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

D. Check Contract Documents, as well as, Submittals and Shop Drawings of all subcontractors to verify and coordinate spaces in which work of Divisions 21 through 28 will be installed.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades. Systems shall be run parallel with or perpendicular to major architectural and structural building elements.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.06 COORDINATION

A. Coordinate arrangement, mounting, and support of piping and equipment:
   1. To maintain maximum headroom; all piping, duct, conduit and associated components to be as tight as possible to underside of structure to provide for ease of disconnecting the equipment with minimum interference to other installations.
   2. To allow right of way for piping installed at required slope.
   3. To 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 HVAC items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

1.07 COORDINATION DRAWINGS

1. When included as part of the Contract Documents, there shall be full cooperation and coordination of all specialty trades.
2. This Division's contractors shall comply fully with the requirements set forth in the "Coordination Drawings" specification section.

1.08 RECORD DOCUMENTS

A. Record Drawings are specified in Division 01 Section "Project Record Documents."

B. The Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing pipe, duct, and piece of equipment. Record documents are to reflect all changes in work including change orders, field directives, addenda from bid set of Contract Documents, request for information responses, etc. Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner in both electronic and hard paper copy formats. Record drawings shall also include:
   1. Locations of buried piping or similar items. Include buried depth.
   2. Field changes of dimension or detail.
   3. Changes made by field order or change order.
   4. Details not on original contract drawings.

1.09 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in a coordinated manual. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.
   1. Copies of all approved submittals/shop drawings.
   2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.
   3. Startup and shutdown procedures.
   4. Flow diagrams.
   5. Test records.
   6. Wiring diagrams.
   7. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment.
   8. Owner's written acknowledgement of satisfactory completion of instruction period.

C. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

D. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions.

1.10 SUBMITTAL PROCEDURE AND FORMAT

A. This Article supplements Division 1.

B. Submittal Cover Sheet
   1. Submittal data for each product shall include a copy of the following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.

2. Shop drawings/submittals shall be submitted according to applicable specification section's requirements with a separate cover sheet completed for each product, rather than one cover sheet for multiple products, whether or not supplied by one manufacturer or vendor.

SHOP DRAWING COVER SHEET				
PROJECT:		CONTRACTOR:		
DIVISION NO.:		SECTION NO.:		
DESCRIPTION:				
CONTRACT DRAWING REFERENCE NO.:				
EQUIPMENT TAG:				
SUBMISSION (CIRCLE ONE): FIRST, SECOND, THIRD, FOURTH				
DATE:				
INFORMATION AND CHECKLIST:				
1.	Contractor's Log #ID			
2.	Name, address, and phone number of supplier.			
3.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes	No	
4.	Is this item a substitution?	Yes	No	
5.	Are deviations clearly identified?	Yes	No	
6.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
7.	Has support, erection, weights, and installation been coordinated with all trades?	Yes	No	
8.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes	No	
9.	Does this material/equipment add expense to any other trade or project costs?	Yes	No	
10.	Does equipment require interface with other trades? List divisions and specifics requiring coordination?	Yes	No	
11.	Is control interface coordinated?	Yes	No	
12.	List electrical characteristics (V/Ph/A)			

C. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be 1/4 inches = 1 foot 0 inch scale unless specified otherwise.

D. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.

E. Provide shop drawing submittals showing details of piping connections to ALL equipment. If connection details are not submitted and connections are found to be installed incorrectly in the field, this contractor shall reinstall them within the original contract price.

F. Shop drawings for different systems and equipment shall be bound separately by specification section as indicated above and not bound by manufacturer. Each separate submittal shall have its own transmittal and cover letter. Submittals which contain different specification section systems bound together may be returned un-reviewed for re-submittal.

1.11 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Electrical Characteristics for HVAC Equipment: Equipment of different 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 at the contractor’s expense. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

C. All electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Skid-mounted or packaged assemblies shall be listed and labeled as an assembly, not just the individual components.

D. Fire-Resistance Ratings: Where indicated, provide penetration firestopping devices tested for fire resistance per ASTM E 814 by a testing agency acceptable to authorities having jurisdiction. Indicate design designations from UL's "Fire Resistance Directory."

E. Acceptable Manufacturers
   1. The Engineer’s design for each product is based on the manufacturer listed in the schedule or shown on the drawings. In Part 2 of some technical specifications, other manufacturers are listed as being acceptable. The listing of a manufacturer as acceptable does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. These are acceptable only if, as a minimum, they:
      a. Meet all performance criteria listed in the schedules and outlined in the specification.
      b. Have identical operating characteristics to those called for in the specification. For example, a two-stroke diesel generator will not be acceptable if a four-stroke model is specified.
      c. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer’s name appears as acceptable shall not be taken

to mean that the Engineer has determined that the manufacturer's products will fit within the available space - this determination is solely the responsibility of the contractor.

d. Products must adhere to all architectural considerations including but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.
e. All equipment shall be labeled or listed by the National Board of Underwriters Laboratories (U.L.) where such labeling or listing exists for such material.

1.12 TEMPORARY SERVICES/CONTINUITY OF UTILITY SERVICES

A. In the absence of specific requirements in Division 1, comply with the following procedures for shut-downs.

B. Provide temporary services where project construction schedule requires extended shut downs of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shut downs are interruptions of existing services for a period of time longer than that acceptable to the Owner.

C. Contractor shall coordinate any shutdowns of existing systems as follows:
1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.
2. Minimize timeline of shutdowns of any system.
3. Provide temporary services where required and perform shutdowns and tie-ins at a time convenient to Owner.
4. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
5. Perform required survey and inspection work required by the notice for shutdown.
6. All life safety systems shall be returned to service at the end of each work day, when work is being performed on the systems. It is the responsibility of the Contractor to provide all associated appurtenances necessary to ensure that the systems are in proper working condition at all times.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment/materials from damage during shipping, storage, handling and installation. Delivery equipment/materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic. Specialties shall not be stored outdoors.

C. Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional expense. Do not store equipment with PVC material with exposure to direct sunlight.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection. This is applicable for all Division 23 sections.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.03 FLASHING MATERIALS

A. All piping through roofs shall be flashed. Flashing materials and methods shall be in accordance to the manufacturer's requirements.

2.04 CEILING ACCESS AND ACCESS PANELS

A. Access panels are generally not shown on the drawings, but they are required to be provided by the Division 1 Contractor. Divisions 23 contractor shall closely coordinate all required access panels with the Division 1 Contractor.

B. Provide proper access to materials and equipment that require inspection, replacement, repair or service, and coordinate their delivery with the installing Trade. If proper access cannot be provided, confer with Architect as to best method of approach for minimizing effect of reduced access which may result.

C. The maximum distance from the ceiling line to serviceable equipment (i.e., air terminal boxes, valve handles, volume damper handles, etc.) shall be 24 inches unobstructed, unless otherwise noted on the drawings.

D. Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment and deliver to a representative of the installing Trade. Furnish and install distinctively colored buttons (color as selected by Architect) in finished ceiling to identify all access panels.

E. Ceilings consisting of lay-in or removable splined tiles do not require access panels. Fire, control dampers, valves and equipment located above ceiling shall have location marked with color-coded identification screws attached to the ceiling "grid." Location shall be noted on record drawings.

F. Furnish access panels for installation under other Sections for valves or other items installed under this Division that require access and are concealed in floor, wall, furred space or above ceiling. Coordinate selection with other Sections supplying similar access panels. Color of panel shall be selected by the Architect.

G. Access panels shall have same fire rating classification as surface penetrated. Rated access panels must have U.L. Label.

H. Panels shall be at least 12 inches x 12 inches; access panels at equipment (VAV boxes, fan boxes and others) shall be at least 18 inches x 18 inches.

PART 3 - EXECUTION

3.01 PRE-BID SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this division. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment

shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

C. The documentation of existing conditions was derived from As-Built documents and are in part unverified. Actual existing conditions shall be verified prior to commencement of work.

3.02 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. All equipment shall be installed per the manufacturer's installation requirements.

B. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. 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.

E. Install equipment to allow right of way for piping installed at required slope.

F. If it is determined that in order to install equipment in an existing space, disassembling of the equipment will be required, the Architect shall be notified immediately, prior to ordering equipment. Confirmation that equipment factory warranties will not be voided shall be confirmed in writing. Arrangements for factory-authorized assembly at the job site shall then be made and be considered part of the construction cost

3.03 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.

3.04 CONCRETE BASES

A. Provide raised concrete pads for all floor mounted equipment.

B. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes (if applicable) at Project. Where specific requirements are not specified in Division 3 or detailed on the Drawings, comply with the following at a minimum:
   1. Construct concrete bases 4 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated. Bases for air handling units shall be 6 incheshigh.
   2. Edges of concrete bases shall have a minimum 1-1/2 inch chamfer.
   3. 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.
   4. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   5. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   6. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.
   7. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   8. Use 3000-psi, 28-day compressive-strength concrete with wire-mesh reinforcement.

3.05 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.

D. Fireproofing:
   1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.
   2. Piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
   3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

3.06 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.

3.07 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.

3.08 WELDING

A. Weld only by approved acetylene or electric welding processes and welders shall hold certificate from approved insurance company.

B. Conduct test to demonstrate suitability of procedures to be used in making welds, which conform to specified requirements.

C. Specification for welding procedure shall meet requirements of Welding Qualifications, Section IX, ASME Boiler and Pressure Vessel Code and ANSI B31.1.

D. Align components. No strain shall be placed on weld during welding. No part of pipe shall be offset more than 20% of thickness. Set flanges and branches properly.

E. Welder and Brazing Qualification:

1. Test welders to demonstrate ability to make acceptable welds. Tests conducted for qualification of welder for work under one Division or Section shall not necessarily qualify welder for work under another Division or Section.
2. Tests shall be as prescribed for welder qualification in Section IX of the ASME code.
3. Records of such tests shall be as follows: Each welder shall be assigned an identifying number, letter or symbol. Identifying mark shall be stamped adjacent to welds made by this welder. Identification shall be at top of horizontal piping and at front of vertical piping.
4. Maintain record of welders employed, showing dates and results of tests and identifying mark assigned to each welder. Certify records and make them accessible to Owner's project representative and/or project manager. Before completion of project, one copy of records shall be turned over to Owner.
5. No qualification shall be older than three years when welder commences work on this project. If welder has not welded in required welding process for a period of six months, he shall be re-certified.

F. Welding Tests
1. As designated by Architect, remove welds for destructive testing or for testing by non-destructive means. Tests shall be as determined by Architect.
2. If, in Architect's opinion, welds so tested do not meet requirements of Sections VIII and IX of ASME, then the Contractor shall pay for the costs of the tests. Remove welds welded by that welder, at no cost to the Owner. Rewelding shall be performed by qualified welder other than welder whose welds did not pass test. Welders whose welds were defective shall not be employed on site for remainder of project.
3. Welding of stanchions, brackets, anchors and other welding not performed on pipe joints shall be in accordance with requirements of AWS specifications and requirements.

3.09 INSTALLATION ONLY ITEMS:

A. Where this contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This contractor shall be responsible for:
1. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
2. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

B. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

3.10 AIRBOUND SYSTEMS

A. If, after project is in operation, any piping systems, coils or other apparatus are stratified or air bound (by vacuum or pressure), they shall be re-piped with new approved and necessary fittings, air vents, or vacuum breakers at no extra cost to the Owner. If connections are concealed in furring, floors, or ceilings, this trade shall bear all expenses of cutting, patching and refinishing construction and finish, leaving same in as good condition as before it was disturbed.

3.11 CLEANING

A. Cleaning shall be performed prior to system start-up.

B. Ductwork
1. Ducts shall be thoroughly cleaned so that no dirt or dust will be discharged from diffusers, registers or grilles, when system is operated.

2. Clean all ductwork both internally and externally to remove all dirt, plaster dust or other foreign materials. When external surfaces of ductwork are rusted, clean and restore surfaces to original condition.
3. Provide temporary connections required for cleaning. Provide cheesecloth for openings during cleaning.
4. Replace filters prior to final inspection and testing.

C. Piping
   1. General:
      a. After all piping systems have been pressure tested and approved for tightness, flush and clean piping as specified and as required by codes.
      b. Furnish pipe cleaning chemicals, chemical feed equipment, materials and labor necessary to flush and clean piping.
      c. Permanently install necessary chemical injection fittings complete with stop valves.
      d. Monitor the water temperatures and prevent the heat generated by the pump circulating the water from causing the water temperature to exceed the temperature ratings of the pipe, pumps, and other components of the piping system during the flushing and cleaning process.
      e. Contractor to provide a portable temporary pumping apparatus for the purpose of flushing and cleaning. Pump shall be adequate to provide the required velocities necessary for the process.
      f. When external surfaces of piping are rusted, clean and restore surfaces to original condition.
   2. Flushing:
      a. All water side equipment control valves, strainers, etc., shall be bypassed prior to and during the flushing process.
      b. Flush all water, steam and condensate systems clear of all dirt and foreign matter with all pumps bypassed. All flushing to be at a circulation rate of 6 f.p.s.
      c. Maintain continuous blowdown and make-up, as required during flushing operation.
      d. Once flushing is complete and prior to cleaning, all final connections to equipment shall be performed.
      e. Water samples taken from the system during flushing shall determine when the system is ready for the cleaning process.
   3. Cleaning:
      a. Clean all pipeline strainer baskets and return to original condition or replace with new baskets prior to the pipe cleaning process.
      b. The cleaning chemicals shall be designed to remove deposition from construction, such as pipe dope, oils, loose mill scale, and other extraneous silt and mud. The products shall inhibit corrosion of the various metals in the system and shall be safe to handle and use with normal chemical safety equipment, i.e., gloves and safety glasses. Effectiveness of the product shall be such that the water need only be at ambient temperatures.
      c. During the cleaning procedure, remove strainers, automatic air vents, flow regulators and any other item that would be affected by the clean and flush procedure. All control valves and coils should be set up for wide open, full flow.
      d. After initial flushing of a system, use portable pumping apparatus for a continuous 24 hour circulation of a cold water detergent equal to Nalco 2567 cleaner.
      e. After circulating for the prescribed time, systems shall then be drained and flushed until the total alkalinity or conductivity of the rinse water is not more than 20% higher than the readings for the make-up water. Refill with clean water, and treat with scale and corrosion inhibitor. Contractor shall furnish the chemicals, supervise the cleaning, test the water after flushing, and shall provide a report that certifies successful cleaning and flushing of the piping.

3.12 COMMISSIONING

A. The Commissioning Authority will be Owner furnished and under direct contract with the Owner. That is, the General Contractor and this subcontractor's bid price shall not include the services of the Commissioning Authority but shall include costs for coordination testing, Contractor commissioning, etc.

END OF SECTION

SECTION 230510

HVAC DEMOLITION AND ALTERATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:
   1. Disconnection of mechanical equipment in selected portions of building or structure.
   2. Demolition and removal of selected mechanical components.
   3. Salvage of existing items to be reused or recycled.

B. Related Requirements:
   1. Division 01 Section "Cutting and Patching."
   2. Division 02 Section "Selective Structure Demolition" for sequencing and scheduling procedures and requirements for demolition activities.

1.03 JOB CONDITIONS

A. Perform all demolition as needed to accomplish new work.

B. Do not rely solely on mechanical drawings to determine extent of general construction demolition. Refer to architectural demolition plans for the exact extent of general construction demolition required by this contract.

C. This Contractor is responsible for all charges, fees etc. incurred as a result of the mechanical portion of the demolition.

D. Prior to demolition or alteration of structures, the following shall be accomplished:
   1. Review available record documents of the existing construction. Owner does not guarantee that existing conditions are same as those indicated in record documents.
   2. Coordinate sequencing with Owner and other Contractors.
   3. Coordinate means to separate construction zones from non-renovated zones to prevent the spread of dust, fumes and debris.
   4. Coordinate means to provide exhaust and makeup air to maintain the construction zone at an adequate negative pressure to contain all construction dust and fumes.
   5. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work.
   6. Equipment noted to be removed and turned over to the Owner, shall be delivered to the Owner at a place and time he so designates.
   7. Where the materials are to be turned over to the Owner or reused and installed by the Contractor, it shall be the Contractor's responsibility to maintain the condition of the materials and equipment equal to that existing before work began. Damaged materials or equipment shall be repaired or replaced at no additional cost to the Owner.
   8. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restore existing facilities to their pre-demolition condition, at no additional cost to Owner.
   9. Salvage equipment scheduled for reuse in new work or scheduled to be delivered to Owner's storage facility.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.01 DEMOLITION

A. Existing mechanical equipment in conflict with new construction shall be removed and/or relocated as indicated on the drawings, as directed or needed. This Contractor shall remove all mechanical equipment released from service as a result of construction, and no equipment removed shall be reused, except as specifically directed on the drawings or elsewhere herein. All mechanical components shall be stored on site for Owner assessment. Any components not retained by the Owner shall be removed by the contractor. Properly dispose or remove from site any items not retained by Owner.

B. Any existing services or equipment not shown on the drawings and which are logically expected to be continued in service and which may be interrupted or disturbed during construction, shall be reconnected in an approved manner. Provide temporary ducts, pipes, controls, etc., as needed to prevent interruption of service to occupied areas caused by demolition operations. In addition, any ductwork, piping or equipment which may require relocation or rerouting as a result of construction, shall be considered a part of the work of this section and shall be done by this Contractor with no additional compensation, provided that the referenced relocation is discernable from the pre-bid review of the site, and associated documents.

C. This Contractor shall remove all ductwork, piping, straps, and existing equipment, being discontinued or removed due to construction. Abandoned or removed services shall be disconnected and capped at the perimeter of the project or as required elsewhere in the documents.

D. The existing building is to remain in operation during construction. This Contractor shall coordinate all work including shutdowns for removing or adding equipment that will interfere with the present operation of the facility with the Owner and Construction Manager.

E. All existing equipment that is to remain shall be cleaned inside and out. Clean all pipeline strainer baskets and return to original condition or replace with new baskets. All dirt, plaster dust and other foreign matter shall be blown and/or cleaned from coils, terminal devices, diffusers, registers, and grilles. Touch up paint equipment in exposed areas.

F. Ductwork systems indicated to remain shall be wiped or vacuumed clean both internally and externally to remove all dirt, plaster dust or other foreign materials.

G. Existing ductwork systems that are being extended or modified to serve this project shall be cleaned inside and out in accordance with the National Air Duct Cleaners Association (NADCA) standards. This includes the addition of access panels necessary to reach the complete duct system back to its air handling unit or fan.

H. Existing ductwork in remodeled area that is not being removed shall be sealed as necessary to comply with SMACNA standards and requirements of ductwork section of the specifications.

I. All coring that is required for mechanical work shall be done by this Contractor.

J. All cutting and patching required for mechanical work shall be by this Contractor.

K. This Contractor shall provide required additional support for existing ductwork and piping in remodeled area that is not being removed and is not properly supported.

L. When existing ductwork, piping, or related equipment in remodeled areas prevents the installation of other work, remove and reinstall existing materials, making necessary modifications and transitions to coordinate with other trades.

M. Maintain construction zone at adequate negative pressure by providing exhaust by mechanical means until all work which creates dust or fumes is completed.

N. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed unless noted otherwise.
   1. Components to Be Removed: Remove associated HVAC system components including all associated piping, ductwork, supports, grilles, power and controls.
   2. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   3. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   4. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
   5. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
   6. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   7. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
   8. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

O. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

P. Contractor shall verify that all equipment to be re-used is in satisfactory and functional condition. Notify the architect and engineer of any deficiencies before removing the equipment.

3.02 CLEANING AND REPAIR

A. Clean existing materials and equipment which remain or are to be reused. Report damage or defects to Architect

3.03 TESTING

A. Existing equipment shall be tested before demolition begins to determine existing operating conditions and capacities. Upon completion of all new work, the existing equipment shall be rebalanced to serve the new areas and maintain existing capacities in existing areas.

END OF SECTION

SECTION 230511

HVAC AIR DUCT CLEANING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes cleaning of the following existing duct systems:
   1. Supply system.
   2. Return system.
   3. Exhaust system.
   4. Outdoor system

B. Related Sections:
   1. Division 23 Section “HVAC Demolition and Alteration”.
   2. Division 23 Section “HVAC Insulation”.
   3. Division 23 Section “Metal Ducts”.
   4. Division 23 Section “Air Duct Accessories”.
   5. Division 23 Section “Indoor Air Quality”.
   6. ICRA: Refer to Facility Infection Control and Risk Assessment Requirements

1.03 DEFINITIONS

A. ASCS: Air system cleaning specialist.

B. NADCA: National Air Duct Cleaners Association.

C. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

D. HASC: HVAC Air System Cleaning.

1.04 SUBMITTALS

A. Qualifications: The HASC Contractor shall submit a company resume listing personnel and project experience and a copy of the company’s Supervisor ASCS certificate.

B. Procedures and Agenda: The HASC Contractor shall submit the HASC procedures and agenda proposed to be used.

C. Reports.
   1. Submit six certified bound copies of the final reports on applicable NADCA Reporting Forms for review and approval by the Engineer.
   2. The final HASC Report shall include the following:
      a. Success of the cleaning project, as verified through visual inspection and gravimetric vacuum analysis.
      b. Areas of the system found to be damaged and/or in need of repair

1.05 QUALITY ASSURANCE

A. ASCS Qualifications: A certified member of NADCA.
   1. Certification: Employ an ASCS certified by NADCA on a full-time basis
   2. Supervisor Qualifications: Certified as an ASCS by NADCA.
   3. Experience: Submit records of experience in the field of HVAC systems cleaning.
   4. Equipment, Materials, and Labor: Have equipment, materials, and labor required to perform specified services.

B. Comply with current published standards of NADCA.

1.06 DESIGN CRITERIA

A. This Contractor shall be responsible for providing existing HVAC Air System Cleaning of systems indicated on the drawings including systems and the equipment and apparatus connected.

B. The work included in this section consists of furnishing labor, instruments, and tools required for HVAC Air System Cleaning Services as specified in accordance with the Contract Documents.

C. Provide labor, materials and confinement system required to comply with the mitigation recommendations of the facility's Infection Control and Risk Assessment (ICRA). Work includes necessary project phasing, work schedule and confinement system, which shall all comply with the requirements of the ICRA.

D. The air systems requiring cleaning include but are not limited to the following:
   1. Air handling and fan coil units.
   2. Ductwork systems – metal externally insulated
   3. Fans
   4. Terminal Unit Equipment
   5. Diffusers, Registers and Grilles
   6. HVAC Coils

E. Duct sections and HVAC equipment utilizing insulation exposed to the air stream such as duct liner shall be reported to the engineer prior to any cleaning attempts. Report shall indicate areas where used, materials of construction and Contractor's recommendation on effectiveness of proposed cleaning methodology.

F. Upon completion of cleaning, the HASC Contractor shall test additional sections of the metal duct system randomly, chosen by Owner/Architect/Engineer for verification that cleaning is complete.

G. HVAC Air System Cleaning shall be performed in accordance with the current published Standards of NADCA. If these contract documents set forth more stringent requirements than the referenced Standards, these contract documents shall prevail

PART 2 - PRODUCTS

2.01 INSTRUMENTS

A. All instruments used for measurements shall be accurate, and calibration histories for each instrument shall be available for examination. Calibration and maintenance of all instruments shall be in accordance with the requirements of NADCA Standards:

2.02 PATCHING MATERIALS

A. Use same products as used by original Installer for insulation, ductwork and housings which have been cut for cleaning purposes. Unless indicated otherwise, products shall comply with related work of these project specifications.

2.03 SHEET METAL 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.

2.04 DUCT MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Rectangular Duct Door: Double wall; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include butt or piano hinge and cam latches.

C. Round Duct Door: Double wall; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 2” thick fibrous-glass

PART 3 - EXECUTION

3.01 GENERAL

A. This specification defines the ***minimum*** requirements necessary to render HVAC components clean, and to verify the cleanliness through inspection and/or testing in accordance with items specified herein and applicable NADCA Standards

B. The Contractor shall be responsible for the removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications for areas indicated on the project plans.

C. The HVAC air system includes any interior surface of the facility’s air distribution system for conditioned spaces and/or occupied zones. This includes the entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. The return air grilles, return air ducts to the air handling unit (AHU), the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, humidifiers and dehumidifiers, supply air ducts, fans, fan housing, fan blades, air wash systems, spray eliminators, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the HVAC system.

D. Perform cleaning prior to system air balancing.

E. HASC work shall be performed with dust and fumes contained within a confinement system to minimize impact of construction activity to occupants. HASC activities must be conducted in tight enclosures maintaining negative differential pressure to control the spread of dust, particulates, fumes and debris into patient areas. For HealthCare projects, refer to facility’s ICRA for additional requirements on confinement systems, necessary barriers, facility’s ICRA requirements, negative air machines, exhaust air, make up air and monitoring

3.02 EXAMINATION

A. Prior to the commencement of any cleaning work, the HASC Contractor shall perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment required to satisfactorily complete this project. The cleanliness inspection should include air handling units and representative areas of the HVAC system components and ductwork.

B. The cleanliness inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In Health Care occupancies, in cases where contamination is suspected, and/or in sensitive environments where even small amounts of contaminant may be of concern, environmental engineering control measures shall be implemented in accordance with Construction Confinement System Specifications and NADCA Standards.
   1. Damaged system components found during the inspection shall be documented and brought to the attention of the Owner

C. Contractor shall conduct a site evaluation, and establish a specific, coordinated plan which details how each area of the building will be protected during the various phases of the project .

D. Prepare written report listing conditions detrimental to performance of work.

E. Proceed with work only after unsatisfactory conditions have been corrected.

3.03 CLEANING

A. Engage a qualified ASCS to clean the following systems:
   1. Supply system.
   2. Return system.
   3. Exhaust system.

4. Outside Air System.

B. Air-Volume Control Devices: Dampers and any air-directional mechanical devices inside the HVAC system must have their position marked prior to cleaning and, upon completion, must be restored to their marked position.

C. Use existing openings, existing duct access doors and new duct-mounted access doors, as required, for physical and mechanical entry and for inspection.

D. Particulate Collection and Odor Control:
   1. Where venting vacuuming system inside building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or greater) particles.
   2. When venting vacuuming system outside building, use filtration to contain debris removed from the HVAC system and locate exhaust down wind and away from air intakes and other points of entry into building.
   3. Measures shall be employed to control odors and/or mist vapors during the cleaning process.
   4. Containment: Debris removed during cleaning shall be collected and precautions must be taken to ensure that Debris is not otherwise dispersed outside the HVAC system during the cleaning process.

E. Clean the following HVAC system components by removing visible surface contaminants and deposits:
   1. Air distribution systems.
   2. Air outlets and inlets (registers, grilles, and diffusers).
   3. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
   4. Air-handling-unit internal surfaces and components including mixing box, coils, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
   5. Terminal Units (VAV, Constant Volume, Dual duct boxes, reheat coils, etc.)
   6. Coils and related components.
   7. Air dampers, turning vanes and actuators.
   8. Assure that a suitable operative drainage system is in place prior to beginning AHU wash down procedures.
   9. Clean all coils and related components, including evaporator fins.

F. Mechanical Cleaning Methodology:
   1. The HVAC system shall be cleaned using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility. It is the contractor's responsibility to select Source Removal methods that will render the HVAC system Visibly Clean and capable of passing cleaning verification methods and other specified tests, in accordance with all general requirements. No cleaning method, or combination of methods, shall be used which could potentially damage components of the HVAC system or negatively alter the integrity of the system
      a. Cleaning methods shall be employed such that all HVAC system components must be Visibly Clean as defined in applicable standards (see NADCA Standards). Upon completion, all components must be returned to those settings recorded just prior to cleaning operations
      b. Clean metal-duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
      c. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of ducts so areas being cleaned are under negative pressure.
      d. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts or duct liner.

e. Clean fibrous-glass duct liner with HEPA vacuuming equipment, and do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
f. Clean coils and coil drain pans according to latest version of NADCA. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
g. Provide operative drainage system for washdown procedures.
h. Biocidal Agents and Coatings: Apply biocidal agents if fungus is present; use according to manufacturer's written instructions after removal of surface deposits and debris.

G. Cleanliness Verification:
1. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
2. Visually inspect metal-duct systems for contaminants.
3. Where contaminants are discovered, reclean and reinspect duct systems.

H. Antimicrobial Agents and Coatings:
1. Antimicrobial agents shall only be applied if active fungal growth is reasonably suspected, or where unacceptable levels of fungal contamination have been verified through testing.
2. Application of any antimicrobial agents used to control the growth of fungal or bacteriological contaminants shall be performed after the removal of surface deposits and debris.
3. When used, antimicrobial treatments and coatings shall be applied in strict accordance with the manufacturer’s written recommendations and EPA registration listing.
4. Antimicrobial coatings shall be applied according to the manufacturer’s written instructions. Coatings shall be sprayed directly onto interior ductwork surfaces, rather than “fogged” downstream onto surfaces.

3.04 HEALTH AND SAFETY

A. Safety Standards: Cleaning contractors shall comply with applicable federal, state, and local requirements for protecting the safety of the contractor’s employees, building occupants, and the environment. In particular, all applicable standards of the Occupational Safety and Health Administration (OSHA) shall be followed when working in accordance with this specification.

B. Occupant Safety: No processes or materials shall be employed in such a manner that they will introduce additional hazards into occupied spaces.

C. Disposal of Debris: All Debris removed from the HVAC System shall be disposed of in accordance with applicable federal, state and local requirements.

3.05 DUCT ACCESSORIES INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install duct-mounting access doors where access doors do not currently exist to allow for the cleaning of ducts, accessories, and terminal units as follows:
1. On both sides of duct coils.
2. Downstream from volume dampers, turning vanes, and equipment.
3. Adjacent to fire or smoke dampers; reset or install new fusible links.
4. Before and after each change in direction, at maximum 50-foot spacing.
5. On sides of ducts where adequate clearance is available.

D. Install the following sizes for duct-mounting, rectangular access doors:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body Plus Ladder Access: 25 by 17 inches.

E. Install the following sizes for duct-mounting, round access doors:
1. One-Hand or Inspection Access: 8 inches in diameter.
2. Two-Hand Access: 10 inches in diameter.
3. Head and Hand Access: 12 inches in diameter.
4. Head and Shoulders Access: 18 inches in diameter.
5. Body Access: 24 inches in diameter.

3.06 CONNECTIONS

A. Reconnect ducts to fans and air-handling units with existing flexible connectors after cleaning ducts and flexible connectors. Replace existing damaged and deteriorated flexible connectors.

B. Where existing air inlets and outlets were connected with flexible duct, reconnect with new flexible duct in accordance with project specifications.

3.07 FIELD QUALITY CONTROL

A. Gravimetric Analysis: Sections of metal-duct system, chosen randomly by Owner or Architect, may be tested for cleanliness according to NADCA vacuum test gravimetric analysis.
1. If analysis determines that levels of debris are equal to or lower than suitable levels, system shall have passed cleanliness verification.
2. If analysis determines that levels of debris exceed suitable levels, system cleanliness verification will have failed and metal-duct system shall be recleaned and reverified.

B. Verification of Coil Cleaning: Cleaning shall restore coil pressure drop to within 10 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.

C. Report results of tests in writing

END OF SECTION

SECTION 230513

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

B. Related Sections Include:
   1. Division 26 Section “Enclosed Switches and Circuit Breakers”.
   2. Division 26 Section "Enclosed Controllers”
   3. Division 26 Section “Variable-Frequency Motor Controllers”.

1.03 DEFINITIONS

A. ODP: Open Drip Proof

B. TEFC: Totally Enclosed Fan Cooled

1.04 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

B. Provide all motors, power transformers, control power transformers and all electrically powered or electrically controlled equipment.

C. Drawings and/or specifications show number and horsepower rating of all motors, together with their actuating devices. Should any change in size, horsepower rating or means of control be made to any motor or other electrical equipment after the contracts are awarded, Division 23 Contractor is to immediately notify General Contractor of change. Any additional costs due to these changes shall be the responsibility of Division 23 Contractor.

D. Division 26 Contractor will provide power wiring to starter, disconnect and motor and connect all equipment complete and ready to operate. Division 23 Contractor shall provide all control wiring line and low voltage, including temperature control wiring and associated conduit for all control wiring.

E. Wire all equipment associated with this contract, including interlock wiring, except wiring which is scheduled to be done by others.

F. Provide wiring diagrams to Division 26 Contractor for all apparatus indicating external connection and internal controls.

1.05 STARTERS, VFD’s, AND DISCONNECTS BY DIVISION 26

A. All starters, disconnects, VFDs, relays, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment shall be furnished and installed by Division 26 contractor, except as specifically noted elsewhere in these specifications.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or individual specification sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Select motors for conditions in which they will be required to perform; i.e., general purpose, splashproof, explosion proof, standard duty, high torque, or any other special type as required by the manufacturer's recommendations.
   1. Furnish ODP Motors for indoor non-hazardous environments.
   2. Furnish Inverter Duty motors for all applications connected to variable frequency drives.
   3. Furnish motors with splash proof or weatherproof housing where required or recommended by the manufacturer.
   4. Furnish TEFC motors for exposed outdoor installations and corrosive environments.
   5. Furnish Severe Duty motors complying with IEEE-841 standards for severe duty and hazardous locations.

D. All motors shall be furnished for starting in accordance with utility requirements, and shall be compatible with starters, as specified under Division 26 specifications.

E. Motors located inside air handling units in a clean airstream may be ODP motors.

2.02 MOTOR CHARACTERISTICS

A. Refer to the equipment schedules and specification sections for specific voltages required.

B. All motors shall be 1750 RPM, unless otherwise noted.

C. Polyphase motors for direct drive applications with variable frequency controllers shall be selected at a speed equal to or less than the design speed of the fan or pump, unless scheduled otherwise. Motors shall be selected to allow operation at 60 hertz without exceeding nameplate ratings or considering service factor.

D. Motors 1 horsepower and larger shall be premium efficiency, unless otherwise noted.

E. Motors shall meet or exceed efficiency levels per energy code for intended duty.

F. Duty: Continuous duty at ambient temperature of 104 deg C (40 deg C) and at altitude of 3300 feet above sea level.

G. 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.

H. Provide electronic commutation (EC) single phase motors or polyphase motors with variable frequency drive for direct drive applications with speed control by 0-10 VDC signal or dial mounted potentiometer.

2.03 PREMIUM EFFICIENCY POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.
   1. Efficiency: Meet or exceed the most stringent of the applicable Energy Code, NEMA Premium efficiency standards, as defined in NEMA MG 1 or the efficiencies listed below when tested in accordance with IEEE Standard 112, Method B procedures as stated in NEMA MG 1-12.53a.

	Open Drip-Proof			Totally Enclosed Fan-Cooled		
Number of Poles	6-pole	4-pole	2-pole	6-pole	4-pole	2-pole
RPM	1200	1800	3600	1200	1800	3600
HP						
1	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2	87.5	86.5	85.5	88.5	86.5	85.5
3	88.5	89.5	85.5	89.5	89.5	86.5

B. Service Factor: 1.15.

C. Multispeed Motors: Separate winding for each speed.

D. Rotor: Random-wound, squirrel cage.

E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

F. Temperature Rise: Class B.

G. Insulation: Class F.

H. 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.

I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 Part 31 requirements for thermally protected motors.
   5. Motors connected to variable frequency controllers shall have shaft grounding devices meeting the following requirements
      a. Shaft grounding shall be a bearing isolator, or labyrinth seal, that includes a built-in grounding ring and brush. The brush shall contain conductive microfibers that completely surround the shaft to discharge any current flowing through it.
      b. Motors less than 100 HP size shall be provided with a single shaft grounding ring provided on the drive end of the motor.
      c. Motors 100 HP size and larger shall be provided with a shaft grounding ring on both ends of the motor shaft or shall have an insulated ceramic bearing installed on the non-drive end of the motor and a shaft grounding ring installed on the drive end of the motor.
      d. Apply a fast drying silver paint on the shaft surface to prevent corrosion.
      e. Shaft grounding ring wear shall be less than 0.001” in 10,000 hours with a fiber wear length designed for expected life 200,000+ hours based on testing. Shaft grounding rings

shall be compatible with operating environments ranging from -40° F to 300° F C) and 0-90% RH (non-condensing).

f. AEGIS SGR™ Bearing Protection Ring as manufactured by Electro Static Technology (EST).

2.05 SINGLE-PHASE MOTORS

A. Motors 1/2 HP and below shall be single-phase motors, unless scheduled otherwise.

B. Motors shall be one of the following types as required for the application and/or as scheduled, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Capacitor start, capacitor run.
   3. Electronic commutation (EC).

C. Multispeed Motors: Variable-torque, permanent-split-capacitor type or electronic commutation type.

D. Variable Speed applications: Electronic commutation type.

E. Bearings: Permanently lubricated and sealed, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading. Motors 1/8 HP and below may be shaded pole type with permanently oiled unit bearings.

F. Thermal Protection: Internal thermal overload protection for single phase motors 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.

G. EC Motors: Minimum of 80% efficient at all speed settings. Internal motor circuitry converts AC power to DC power to operate the motor with transformer, speed controllable down to 20% full speed utilizing a 0-10 VDC signal. Motor to include integrated electronics, overload protection, short circuit portion and speed controls. Speed controller to be either integral or remote mounted speed controller manual dial type potentiometer or motor speed is automatically controlled with 2 speed controller or by a 0-10 VDC signal from the control system.

H. Separate Overload Device: Manufacture to include a fused controller or other separate overload device integral to the equipment for motors without internal thermal overload protection.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. For purposes of this specification, “corrosive” environments shall be considered as:
   1. Exterior spaces within 10 miles of the coast.
   2. Exterior at Salt Water Theme Parks or Exhibits,
   3. In areas designated as “water treatment” or “wet”, including but not limited to: areas over and within 15'-0" of open water tanks, pools or basins; splash zones; submerged conditions; ozone rooms; chemical rooms; salt water environments; and other water treatment zones.

B. Examples of severe duty spaces would include but not be limited to industrial applications and chemical processing.

3.02 INSTALLATION

A. Install materials in accordance with details, approved shop drawings, and manufacturer's instructions.

B. Verify thermal overload or overcurrent protection is provided for motors.

END OF SECTION

SECTION 230529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

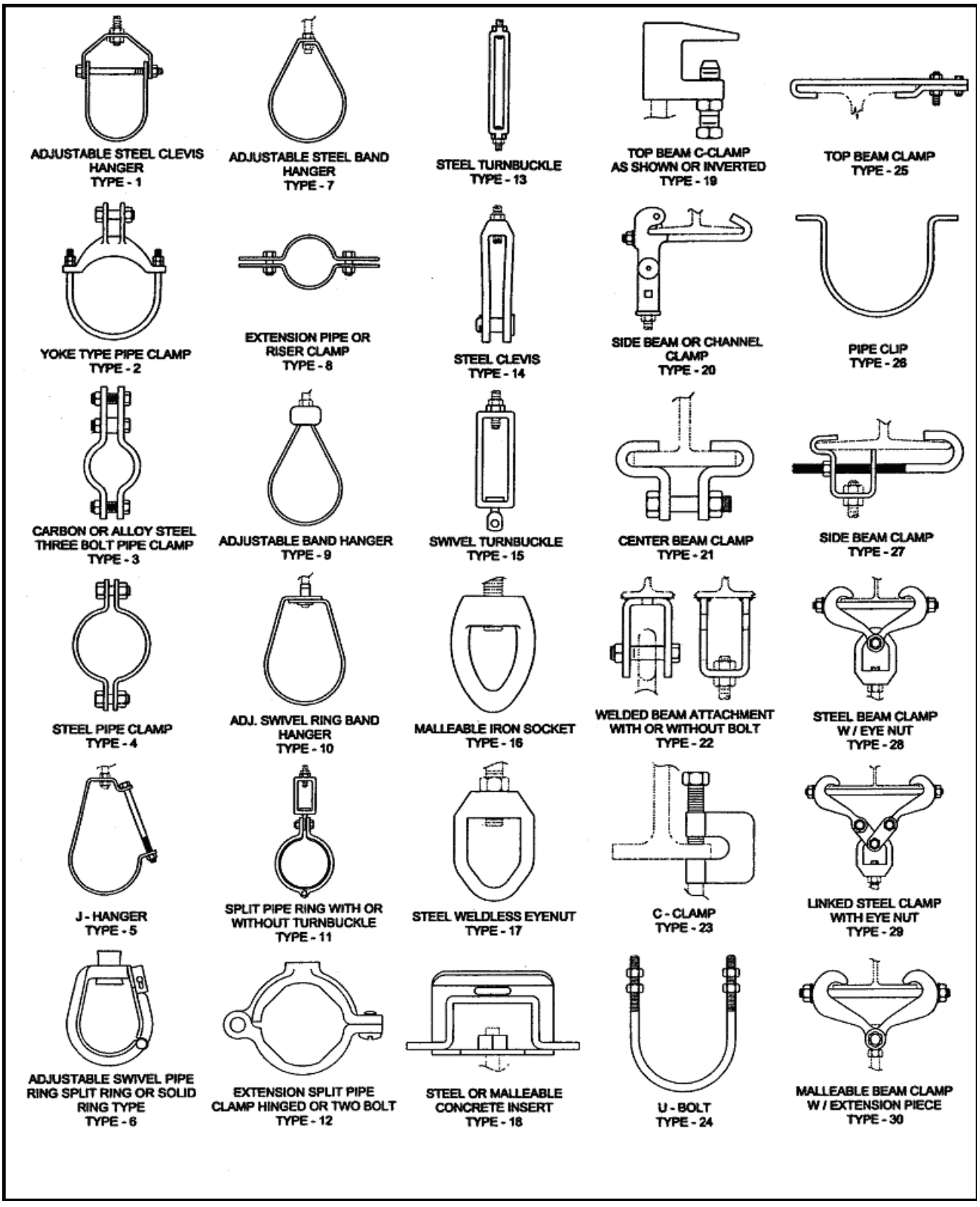
A. This Section includes the following hangers and supports for HVAC system piping and equipment:
   1. Equipment rail supports
   2. Roof equipment curb supports
   3. Equipment Support System
   4. Roof equipment spring curb supports
   5. Roof equipment platform cover
   6. Duct mounting pedestal
   7. Pipe roof curb penetrations
   8. Steel pipe hangers and supports.
   9. Trapeze pipe hangers.
   10. Fiberglass pipe hangers.
   11. Metal framing systems.
   12. Fiberglass strut systems.
   13. Thermal-hanger shield inserts.
   14. Fastener systems.
   15. Pipe stands.
   16. Equipment Support System
   17. Wall Pipe Penetration System

B. Related Sections include:
   1. Division 23 Section "Vibration Controls for HVAC".
   2. Division 23 Section "Seismic Restraints for HVAC".
   3. Division 23 Section “Hydronic Piping”.

1.03 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Description: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports", refer to the following figures when the “Type” hanger or support is indicated in Part 2 and 3 of this specification.


ADJUSTABLE STEEL CLEVIS HANGER TYPE - 1
ADJUSTABLE STEEL BAND HANGER TYPE - 7
STEEL TURNBUCKLE TYPE - 13
TOP BEAM C-CLAMP AS SHOWN OR INVERTED TYPE - 19
TOP BEAM CLAMP TYPE - 25
YOKE TYPE PIPE CLAMP TYPE - 2
EXTENSION PIPE OR RISER CLAMP TYPE - 8
STEEL CLEVIS TYPE - 14
SIDE BEAM OR CHANNEL CLAMP TYPE - 20
PIPE CLIP TYPE - 26
CARBON OR ALLOY STEEL THREE BOLT PIPE CLAMP TYPE - 3
ADJUSTABLE BAND HANGER TYPE - 9
SWIVEL TURNBUCKLE TYPE - 15
CENTER BEAM CLAMP TYPE - 21
SIDE BEAM CLAMP TYPE - 27
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ADJ. SWIVEL RING BAND HANGER TYPE - 10
MALLEABLE IRON SOCKET TYPE - 16
WELDED BEAM ATTACHMENT WITH OR WITHOUT BOLT TYPE - 22
STEEL BEAM CLAMP W / EYE NUT TYPE - 28
J - HANGER TYPE - 5
SPLIT PIPE RING WITH OR WITHOUT TURNBUCKLE TYPE - 11
STEEL WELDLESS EYENUT TYPE - 17
C - CLAMP TYPE - 23
LINKED STEEL CLAMP WITH EYE NUT TYPE - 29
ADJUSTABLE SWIVEL PIPE RING SPLIT RING OR SOLID RING TYPE TYPE - 6
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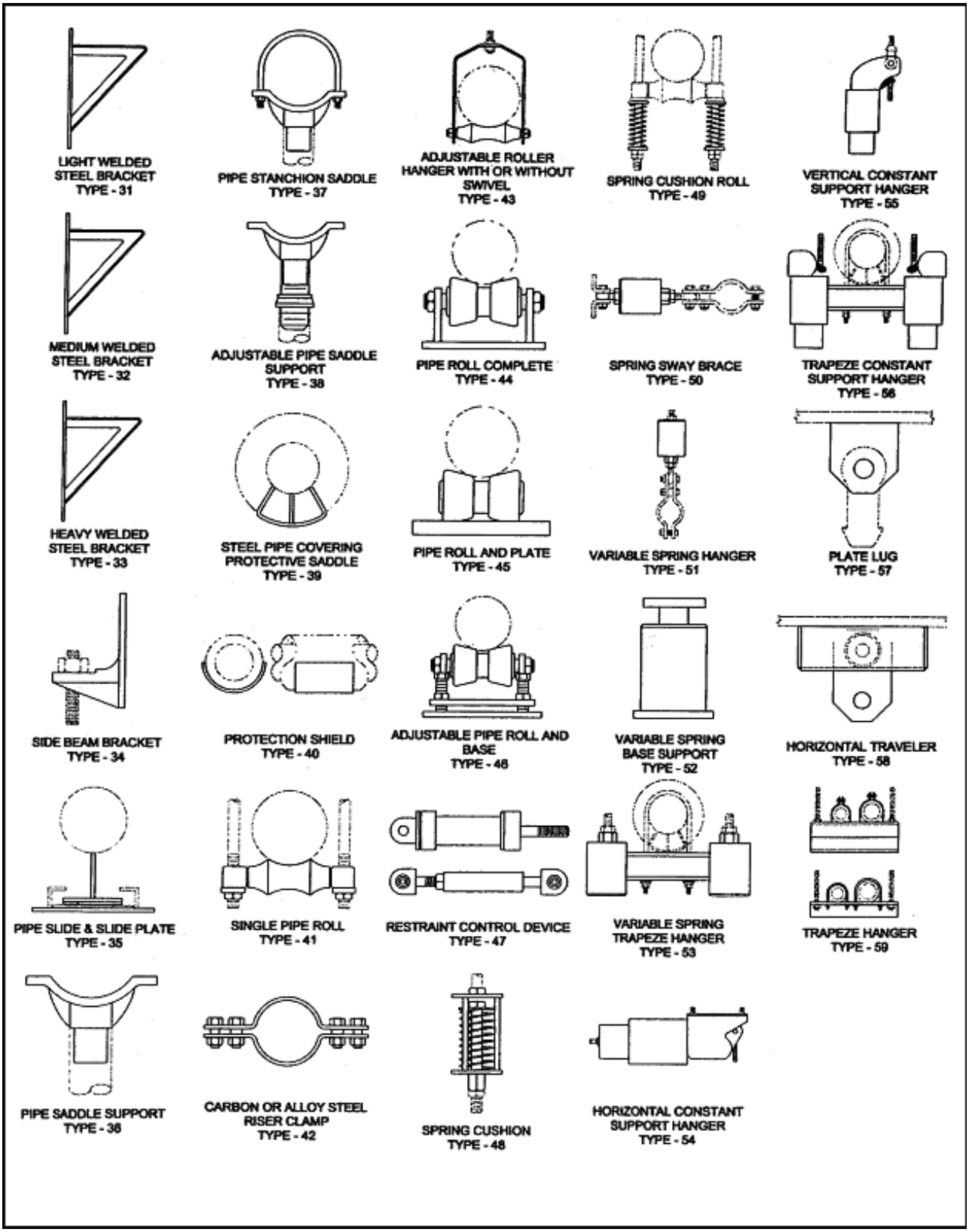
STEEL OR MALLEABLE CONCRETE INSERT TYPE - 18
U - BOLT TYPE - 24
MALLEABLE BEAM CLAMP W / EXTENSION PIECE TYPE - 30


LIGHT WELDED STEEL BRACKET TYPE - 31
PIPE STANCHION SADDLE TYPE - 37
ADJUSTABLE ROLLER HANGER WITH OR WITHOUT SWIVEL TYPE - 43
SPRING CUSHION ROLL TYPE - 49
VERTICAL CONSTANT SUPPORT HANGER TYPE - 55
MEDIUM WELDED STEEL BRACKET TYPE - 32
ADJUSTABLE PIPE SADDLE SUPPORT TYPE - 38
PIPE ROLL COMPLETE TYPE - 44
SPRING SWAY BRACE TYPE - 50
TRAPEZE CONSTANT SUPPORT HANGER TYPE - 56
HEAVY WELDED STEEL BRACKET TYPE - 33
STEEL PIPE COVERING PROTECTIVE SADDLE TYPE - 39
PIPE ROLL AND PLATE TYPE - 45
VARIABLE SPRING HANGER TYPE - 51
PLATE LUG TYPE - 57
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PROTECTION SHIELD TYPE - 40
ADJUSTABLE PIPE ROLL AND BASE TYPE - 46
VARIABLE SPRING BASE SUPPORT TYPE - 52
HORIZONTAL TRAVELER TYPE - 58
PIPE SLIDE & SLIDE PLATE TYPE - 35
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VARIABLE SPRING TRAPEZE HANGER TYPE - 53
TRAPEZE HANGER TYPE - 59
PIPE SADDLE SUPPORT TYPE - 36
CARBON OR ALLOY STEEL RISER CLAMP TYPE - 42
SPRING CUSHION TYPE - 48
HORIZONTAL CONSTANT SUPPORT HANGER TYPE - 54

C. Type of service is defined to mean either “corrosive service” or “normal service”. For purposes of this specification, “corrosive-service” mechanical support devices to be used:
   1. Exterior spaces within 10 miles of the coast.
   2. Exterior at Salt Water Theme Parks or Exhibits,
   3. In areas designated as “water treatment” or “wet”, including but not limited to: areas over and within 15'-0" of open water tanks, pools or basins; splash zones; submerged conditions; ozone rooms; chemical rooms; salt water environments; and other water treatment zones.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. General: Hangers and supports for HVAC piping and equipment shall withstand the effects of loads and stresses within limits and under conditions indicated according to ASCE 7. Design piping and equipment supports, including pipe stands, to support combined loads of supported systems, equipment and system contents.

C. Seismic: Equipment and associated mounting assemblies shall withstand the effects of seismic forces in accordance with project Seismic specifications.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of hanger and support indicated including:
   1. Pipe, duct or equipment hanger: Type of lower attachment, hanger rod, upper attachment and building attachment.
   2. Pipe, duct or equipment support, pedestal or stand: Type of attachment, support and building attachment.
   3. Indicate materials, finishes, approvals and load ratings

B. Shop Drawings: Show fabrication and installation details coordinated with and sized for the associated piping, ductwork and equipment supported.

1.06 INFORMATIONAL SUBMITTALS

A. Wind compliance: Contractor’s certification of compliance with wind structural loading requirements of the Building Code, wind loads identified in “Performance Requirement” article. Coordinate with system or equipment being supported.

B. Seismic Qualification: Manufacturer’s certification of seismic qualification according to ASCE 7. Coordinate with system or equipment being supported.

C. Welding certificates.

1.07 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."
   3. AWS D1.3, "Structural Welding Code--Sheet Steel."
   4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   5. ASME Boiler and Pressure Vessel Code: Section IX.

B. Manufacturers Standardization Society: Hangers and supports in conformance with MSS including:
   1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
   2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
   3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.08 DESIGN CRITERIA

A. Size, select and install hangers and supports in accordance with MSS, unless otherwise specified.

B. When this specification includes both insulation protection shields and thermal pipe shields, Contractor may use either device, coordinated with insulation specifications..

C. Contractor is responsible for proper placement of supporting devices to accommodate insulation and pitching of pipe as specified in other sections.

D. Provide vibration isolation and/or seismic restraints as specified in other sections.

E. Where piping can be conveniently grouped to allow the use of trapeze type supports, the supporting steel shall be by means of standard structural shapes or continuous insert channels.

F. All upper attachments, hangers, supports, rods and other devices shall be of galvanized construction.

PART 2 - PRODUCTS

2.01 EQUIPMENT SUPPORTS

A. Provide all supporting steel, not indicated on the structural drawings, that is required for the installation of mechanical equipment, ductwork, piping and materials, including angles, channels, beams, etc., to suspend or floor support ductwork, piping tanks and equipment

2.02 ROOF EQUIPMENT RAIL SUPPORTS

A. Provide factory fabricated equipment rails for roof mounting of mechanical equipment.

B. Equipment rails shall be manufactured of heavy gauge galvanized steel with fully mitered and welded corners, internally reinforced with integral baseplate and factory installed wood nailer. Height to be as required to maintain height above finished roof indicated.

C. Equipment rails shall be constructed to span a minimum of two structural members and not cantilever more than 6”. Equipment rails shall be level at top with built-in slope when roof deck slopes

2.03 ROOF EQUIPMENT CURB SUPPORTS

A. Provide factory fabricated equipment curbs for roof mounting of mechanical equipment.

B. Roof equipment curb shall be manufactured of heavy gauge galvanized steel with fully mitered and welded corners, internally reinforced with integral baseplate, 1-1/2” thick, 3 lb. density fiberglass insulation, and factory installed wood nailer. Height to be as required to maintain height above finished roof indicated.

C. Equipment curbs shall be level at top with built-in slope when roof deck slopes.

2.04 EQUIPMENT SUPPORT SYSTEM

A. Manufacturer: Miami Tech Inc. or The Metal Shop prefabricated equipment roof support stand or wall support bracket fabricated to meet wind and gravity loads of supported equipment in accordance with the Building Code and ASCE-7.

B. Wall Bracket: Heavy duty all aluminum channels for manufacturer’s fabricated wall brackets designed to support condensing units suitable for concrete or wood wall construction complete with wall anchors and tie down connections for supported equipment. Coordinated tie downs with equipment and vibration isolation requirements.
   1. Rigid Clip: Heavy gauge aluminum tie-down clips designed to attach to base of supported equipment and bracket.

2. Vibration Isolator: Heavy gauge galvanized or stainless steel restrained type isolator designed to attached to supported equipment mounting points and bolted thru to bracket with rubber / spring type isolation per vibration isolation specifications.
3. Tie Down Straps: Brackets designed to include provisions to include galvanized straps or stainless steel aircraft cable to pass over the top of the equipment where additional supports are required by the AHJ. Where vibration isolators are required, tie down straps shall be secured to the upper attachment of the isolator to allow full movement of the isolator.

C. Roof Support Stand: Heavy duty all aluminum channels for manufacturer's fabricated roof stands designed to support condensing units with pipe stanchion with base plate to elevate equipment above roof and complete with roof anchors and tie down connections for supported equipment. Coordinated tie downs with equipment and vibration isolation requirements.
1. Rigid Clip: Heavy gauge aluminum tie-down clips designed to attach to base of supported equipment and stand.
2. Vibration Isolator: Heavy gauge galvanized or stainless steel restrained type isolator designed to attached to supported equipment mounting points and bolted thru to stand with rubber / spring type isolation per vibration isolation specifications.
3. Tie Down Straps: Brackets designed to include provisions to include galvanized straps or stainless steel aircraft cable to pass over the top of the equipment where additional supports are required by the AHJ. Where vibration isolators are required, tie down straps shall be secured to the upper attachment of the isolator to allow full movement of the isolator.

2.05 ROOF EQUIPMENT PLATFORM COVER

A. Provide factory fabricated platform cover for roof curb for roof mounting mechanical equipment.

B. Equipment platform cover shall be manufactured of minimum 18 gage steel curb cap with ¾" pressure treated plywood base with reinforcing channels and equipment support channels or unistrut for positive attachment to supported equipment. Provide stainless steel or galvanized construction as indicated.

C. Platform cover shall be fully welded watertight one-piece construction designed to support equipment indicated and supported by matching roof equipment curb.

2.06 DUCT MOUNTING PEDESTAL

A. Consisting of an equipment rail, "U" shaped support brackets, galvanized threaded rod and galvanized duct slide assembly. The pedestal shall include an equipment rail with galvanized steel slide channel and support bracket bolted to rail.

2.07 PIPE ROOF CURB PENETRATIONS

A. Consisting of a prefabricated roof curb, a laminated acrylic coated ABS plastic curb cover with prepunched holes with EPDM protective rubber cap and stainless steel clamps.

2.08 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Schedule" Article for where to use specific hanger and support types.

B. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.09 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.

2.10 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and square nuts are made of vinyl ester or hex nuts are made of polyurethane or stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.

2.11 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.12 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.

2.13 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.14 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated (stainless steel in corrosive environments), for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

C. Internally Threaded Anchor for Installation into Metal Deck: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a sinz/yellow chromate plating. Anchor shall have a protective sleeve, steel flange with pre-drilled additional fastening holes and placement spring for attachment to metal deck, anchor is to be secured by clamping the deck between the steel flange and the protective plastic sleeve. Anchor shall bear the diameter and the manufactrer name on hexagonal head..

D. Internally Threaded Anchor for Installation into formed wood concrete deck: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating and contained by a plastic flange. Anchor shall have break-off nails for attachment to the surface of wood forms. Anchor will bear the diameter and manufacturer name on hexagonal head.

2.15 PIPE STANDS

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Pipe Stands Zero Roof Penetration Type:
   1. Available Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.
      c. Portable Pipe Hangers.
   2. 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.
   3. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.
   4. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
      a. Base: Plastic.
      b. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
      c. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
   5. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
      a. Bases: One or more plastic.
      b. Vertical Members: Two or more protective-coated-steel channels.
      c. Horizontal Member: Protective-coated-steel channel.
      d. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

C. 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.

2.16 WALL PIPE PENETRATION SYSTEM

A. Manufacturer: Airex Manufacturing ProSystem Kit complete with Titan Outlet and E-Flex Guard.

B. Manufactured Titan Outlet for exterior wall mounting to provide a water proof wall penetration for refrigerant and condensate drain lines routed through exterior walls complete with gasket for mounting to the wall and flexible elastomeric sleeve for routing piping.

C. Manufactured E-Flex Guard made of UV and weather resistant flexible PVC plastic pipe insulation cover suitable for cut to length installation with mechanical fastening system which can be removed and installed on piping.

2.17 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT SCHEDULE

A. Install and size pipe support, hanger rod, pipe stand and upper attachments suitable for indicated service with performance and design criteria as indicated in Part 1 “Performance Requirements” Article.

B. Select type pipe support, hanger rod, and upper attachment to accommodate piping axial movement due to thermal expansion or building movement as indicated in Part 1 “Performance Requirements” Article. For individual piping supports with fixed pipe support, small axial motion may be absorbed by swing of hanger rod up to the greater of a maximum of 4 degrees or manufacturer’s recommendations.

C. Materials
   1. Use hangers and supports with galvanized, metallic coatings for normal service piping and equipment that will not have field-applied finish.
   2. Use stainless-steel or fiberglass hangers and supports for corrosive service.
   3. Use vinyl ester resin fiberglass for “ozone” applications.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Plastic coated or copper-plated hangers shall be provided for copper piping in direct contact with hangers. Use padded hangers for piping that is subject to scratching.

F. Hangers and supports for piping connected in conjunction with rotating or reciprocating equipment shall be spring hangers and supports for a distance of 100-pipe diameters, or a distance of three hangers away from rotating or reciprocating equipment whichever is greater. Isolators shall be as specified under Vibration Isolation.

G. Horizontal-Piping Hangers: Unless otherwise indicated , install the following types:
   1. Adjustable, Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated individual piping:
      a. All systems NPS 2and smaller.
      b. Ambient and cold systems (119deg Fand below) NPS 2 1/2and above not subject to thermal and seismic movement.
   2. Adjustable, Roller Hangers (MSS Type 43): For suspension of noninsulated or insulated individual piping:
      a. Hot systems (120deg Fand above) NPS 2 1/2and above subject to thermal and seismic movement.
      b. All systems NPS 2 1/2and above subject to seismic movement.
   3. Adjustable Trapeze Hangers (MSS Type 49): For suspension of noninsulated or insulated multiple horizontal piping.
      a. Trapeze support selected and sized for associated loads suitable for mounting each pipe with (MSS Type 24) standard U-Bolt pipe strap, strut mounted pipe guide or (MSS Type 41 or 44) pipe roller.
      b. Pipe strap (MSS Type 24) for all systems NPS 1 1/2and smaller.
      c. Pipe strap (MSS Type 24) for ambient and cold systems (119deg Fand below) NPS 2and above not subject to seismic movement.
      d. Pipe roller (MSS Type 41 or 44) for hot systems (120deg Fand above) NPS 2and above subject to thermal and seismic movement.
      e. Adjustable type pipe support for individual piping which requires a specific slope.

H. Horizontal-Piping Supports: Unless otherwise indicated , install the following types when supporting noninsulated or insulated pipe from below either in equipment rooms or at exterior locations:
   1. Adjustable, Pipe Stanchion Saddles (MSS Type 38): For support of individual pipes, NPS 4and larger not subject to thermal movement, with adjustable steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
   2. Adjustable, Pipe Saddle Supports (MSS Type 37): For support for individual pipes, NPS 2 to NPS 8not subject to thermal movement, with all thread rod for height adjustment and U-bolt to retain pipe.
   3. Pipe rails or Pipe Stands: For support of multiple horizontal piping.

a. Rail or stand support selected and sized for associated loads suitable for mounting each pipe with (MSS Type 24) standard U-Bolt pipe strap, strut mounted pipe guide or (MSS Type 41 or 44) pipe roller.
b. Pipe strap (MSS Type 24) for all systems NPS 1 1/2and smaller.
c. Pipe strap (MSS Type 24) for ambient and cold systems (119deg Fand below) NPS 2and above not subject to seismic movement.
d. Pipe roller (MSS Type 41 or 44) for hot systems (120deg F NPS 2and above subject to thermal and seismic movement.
e. Adjustable type pipe support for individual piping which requires a specific slope.

I. Wall-Piping Supports: Unless otherwise indicated , install the following types when supporting noninsulated or insulated pipe from walls either in equipment rooms or at exterior locations:
1. Pipe Stands: For support of multiple horizontal piping either cantilever (MSS type 31, 32, 33) or racked vertically.
a. Pipe stand support selected and sized for associated loads suitable for mounting each pipe with (MSS Type 24) standard U-Bolt pipe strap, strut mounted pipe guide or (MSS Type 41 or 44) pipe roller for horizontal cantilever pipe stand..
b. Pipe strap (MSS Type 24) for all systems NPS 1 1/2and smaller.
c. Pipe strap (MSS Type 24) for ambient and cold systems (119deg Fand below) NPS 2and above not subject to seismic movement.
d. Pipe roller mounted on horizontal cantilever pipe stand (MSS Type 41 or 44) for hot systems (120deg Fand above) NPS 2and above subject to thermal and seismic movement.
e. Adjustable type pipe support for individual piping which requires a specific slope.

J. Vertical-Piping Supports: 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.
3. Piping larger than 4”, of lengths exceeding 30 feet, shall be additionally supported on base elbows secured to the building structure, with flexible supporting hangers, provided at top of riser to allow for pipe expansion.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types suitable for threaded hanger rod connections:
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 suitable to accommodate piping axial movement.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments suitable for piping with little to no axial movement.
4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations suitable to accommodate piping axial movement where swivel action is required.

L. Building Attachments: Unless otherwise indicated and as required by seismic requirements, 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.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the types as indicated in Installation section of this specification.

N. Spring Hangers and Supports:
1. Spring isolators for hangers and supports are specified in Division 23 Section “Vibration Controls for HVAC Piping and Equipment”.

3.02 HANGER AND SUPPORT INSTALLATION

A. Install supporting devices as shown on the drawings, as detailed, and according to manufacturer’s installation instructions.

B. Secure equipment and mounting assemblies to structure with positive attachments in accordance project’s seismic loading requirements.

C. Secure exterior equipment and mounting assemblies to structure with positive attachments in accordance with project’s seismic and/or wind loading requirements.

D. Coordinate support of mechanical, plumbing, electrical, life support systems, and other trades. Piping, ductwork, conduit, etc. located in same area running parallel is to be supported on similar supports.

E. Roof Equipment Rail And Roof Curb Supports installation: Position and attach equipment rails and curbs with structure as detailed. Provide field installed fiber cant strip, flash and counter flash roofing membrane.
1. Size equipment rails and/or equipment curbs to support associated equipment. For equipment rails, contractor may submit alternate method utilizing a full perimeter curb for equipment support for engineer’s review.
2. Install roof curbs in accordance with manufacturer’s instruction of equipment supported.

F. Roof Equipment Platform Cover Supports: Position and attached platform cover to curb and supported equipment as indicated.

G. Pipe Roof Curb Penetrations: Install at points where pipes are penetrating roof. Size pipe roof curbs to support associated piping. Contractor may submit alternate method for engineer’s review.

H. 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.

I. 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. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

J. 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.

K. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

L. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.

M. 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.
   3. Install anchors for metal decking and wood forms prior to the concrete pour according to the manufacturer’s instructions.

N. Pipe Stand Installation:
   1. Pipe Stands: Assemble stand components and secure to equipment room or equipment yard concrete slab.
   2. Roof Curb or Rail Mounted Type: Assemble stand components and secure to roof curb or rail..
   3. Zero penetration pipe supports are acceptable for NPS 2 1/2 and smaller.
   4. Provide insulation shields, support types and slope in accordance with specified requirements.

O. Roof Duct Pedestal Installation:
   1. Roof Curb or Rail Mounted Type: Assemble pedestal components and secure to roof curb or rail.

P. Wall Bracket Equipment Support installation: Install brackets complete with wall anchors for positive attachments from structure to supported equipment. Provide rigid clip tiedowns, unless retrained type vibration isolation is required by vibration isolation specifications. Include installation of additional tie down straps over equipment when required by the AHJ.

Q. Roof Support Stand Equipment Support installation: Install stands complete with roof anchors for positive attachments from structure to supported equipment. Pipe stanchions lengths shall be as required to maintain minimum height above the roof per the Building Code. Provide rigid clip tiedowns, unless retrained type vibration isolation is required by vibration isolation specifications. Include installation of additional tie down straps over equipment when required by the AHJ.

R. Wall Pipe Penetration Installation: Install at points where pipes are penetrating exterior walls. Contractor may submit alternate method for engineer’s review.

S. Install hangers and supports complete with necessary upper attachments, inserts, bolts, rods, nuts, washers, and other accessories.

T. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

U. Support apparatus and material for all conditions of operation, including variations in installed and operating weight of equipment and piping.

V. 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.

W. Install lateral bracing with pipe hangers and supports to prevent swaying.

X. Install building attachments within concrete slabs or attach to structural steel or structural wood. Install additional attachments within 1 foot of elbows and at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

Y. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

Z. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

AA. Insulated Piping: Comply with the following:
1. Risers: Attach riser clamps and spacers to piping.
   a. Attach riser clamp to piping and insulate pipe and clamp for chilled water systems and hot systems with service temperatures above 140 deg F.
   b. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
2. Horizontal Piping: Install hangers and guides to piping.
   a. Protective Shields: MSS SP-58, Type 40, shields on cold and hot piping. Shields shall span an arc of 180 degrees with length sufficient to prevent compression of insulation and associated loss of R-Value.
   b. Protective Saddles: MSS SP-58, Type 39, saddles on hot piping systems and fill interior voids with insulation. Provide with protective shield spanning an arc of 180 degree with length sufficient to accommodate thermal and seismic movement of piping.
   c. Thermal-hanger Shield Inserts (Insulated Pipe Supports): Insulated pipe supports with insulation same thickness as associated piping insulation may be used for cold and hot piping with protective shield spanning an arc of 180 degree with length sufficient to accommodate thermal and seismic movement of piping.
3. Shield Dimensions for Pipe: Length as required for insulation or expansion and not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

3.03 HANGER AND SUPPORT SPACING

A. Install and size hangers and supports for piping systems to meet maximum spacing requirements of the Building Code. Alternate longer spacing per MSS SP-69 are acceptable subject to approval of Authority Having Jurisdiction and subject to structural loading capacity of structure supporting the piping systems. Size hanger rods, trapeze supports, to support the associated loads.

B. Install hangers and pipe stands for steel piping with the following maximum spacing :
1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.

4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

C. Install hangers and pipe stands for drawn-temper copper piping with the following maximum spacing :
1. NPS 3/4: Maximum span, 5 feet.
2. NPS 1: Maximum span, 6 feet.
3. NPS 1-1/2 and NPS 2 Maximum span, 8 feet.
4. NPS 2-1/2: Maximum span, 9 feet.
5. NPS 3: Maximum span, 10 feet.

D. Multiple Pipes of Various Sizes: When supported together on a common trapeze, rail or pipe stand, space for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

F. Support vertical pipe risers less than 30 feet at roof, at each floor, and at additional intervals as required to limit loading on building structure.

3.04 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.

3.05 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.

3.06 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 inch.

3.07 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 230549

SEISMIC RESTRAINT FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 specifications, apply to this section.

1.02 SUMMARY

A. Related Requirements:
   1. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment” for commonly used HVAC supports and installation requirements.
   2. Division 23 Section “Vibration Controls for HVAC” for restrained isolation devices.

1.03 DEFINITIONS

A. ASCE: American Society of Civil Engineers.

B. IBC: International Building Code.

C. CBC: California Building Code.

D. Life Safety \ Emergency Systems:
   1. All systems involved with fire protection, including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust.
   2. All systems involved with production and distribution, of and utilization equipment connected to, emergency power supply.
   3. Fresh air and relief systems on emergency smoke control sequence, including air handlers, conduit, duct, dampers, fans, etc.

1.04 PERFORMANCE REQUIREMENTS

A. Equipment and Distribution Components: Design supports, attachments, and restraints according to IBC CBC and ASCE 7-05 as Delegated-Design.

B. Equipment and Distribution Components: Select support, attachment, and restraint details complying with requirements of IBC CBC and ASCE 7-05 for equipment and distribution components from one of the following Pre-Approvals:
   1. Cooper B-Line (OPA-0114).
   2. SMACNA (OPA-0010).
   3. Mason Industries (OPA-0349).
   4. ISAT (OPA-0485).

C. Use seismic design values shown on structural drawings.

D. Treat components that are part of life safety / emergency systems as having Component Importance Factor = 1.5. Treat other components as having Component Importance Factor = 1.5 if so scheduled on the drawings.

1.05 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For seismic restraint details governed by performance requirements, include analysis data signed and sealed by a professional engineer responsible for their preparation who is qualified for such work in the place of the project.
   1. Design Calculations: Calculate loading due to equipment weight, operation, and seismic forces required to select seismic restraints.

a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors.

2. Include materials and dimensions and identify hardware, including attachment and anchorage devices, for equipment and for manufactured and field fabricated supports.
3. Seismic Restraint Details:
   a. Design Analysis: Support selection and arrangement of seismic restraints.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Identify components, Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices, where applicable.
   c. Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

B. Coordination Drawings: Show proposed locations of supports and restraints for distribution system components.
1. Show coordination of seismic bracing for HVAC & Piping components with other systems and equipment in the vicinity, including other supports and seismic restraints.
2. Reference proposed locations of supports and restraints to Delegated-Design Submittal details.

1.06 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre approved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a State of California licensed structural engineer.

PART 2 - PRODUCTS

2.01 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide products of Mason Industries or a comparable product by one of the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Hilti Inc.
3. Loos & Co.; Seismic Earthquake Division.
4. Mason Industries.
5. ISAT.
6. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components:
1. Components used in Delegated-Design details: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

2.02 FACTORY FINISHES

A. Finish: Manufacturer's standard paint or galvanized.
1. All hardware shall be galvanized. Hot-dip galvanized metal components for exterior use.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive seismic restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing in of reinforcement and cast-in-place anchors to verify actual location before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATION

A. Multiple pipe supports: Secure piping to trapeze members with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Duct supports : Secure duct to trapeze members with method approved for application by an agency acceptable to authorities having jurisdiction.

C. SEISMIC RESTRAINT DEVICE INSTALLATION

D. Install seismic restraint devices for distribution components according to Delegated-Design details.

3.03 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in duct and piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

3.04 FIELD QUALITY CONTROL

A. Tests and Inspections: Test and inspect to meet regulatory requirements.

END OF SECTION

SECTION 230550

VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes items for structural vibration isolation and includes the following:
   1. Mounts.
   2. Bases.
   3. Hangers.
   4. Restraints.
   5. Anchors and guides.
   6. Flexible pipe connections.

B. Related Sections include the following:
   1. Division 23 Section "Seismic Restraint For HVAC" for requirements necessary for compliance with seismic criteria

1.03 ACTION SUBMITTALS

A. Product Data: Provide schedule and product data of isolation devices related to the equipment served. Schedule and data shall indicate isolation materials, isolator heights both free and operating, isolator dimensions, deflections, and isolation efficiency based on lowest operating speed.

1.04 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7-05. Submit ASCE 7-05 special seismic certification as required. Include method used to determine compliance with requirements.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Products and methods of fabrication, subject to compliance with requirements, provide products by one of the following:
   1. Mason Industries
   2. Kinetics Noise Control
   3. Korfund Company
   4. Amber-Booth Company
   5. Victaulic

2.02 MATERIALS

A. All isolation devices shall be designed for the equipment with which they will be used. Materials used shall retain their isolation characteristics for the life of the equipment served. All elastomeric materials shall be industrial grade neoprene. Isolation devices subject to weather shall have hot dipped galvanized finish.

2.03 TYPE 1 MOUNTS – (Neoprene Mount)

A. Mason type ND or rails type RND, double deflection neoprene mounts with cast-in metal inserts for bolting to equipment, and shall have a minimum static deflection of 0.35".

2.04 TYPE 2 MOUNTS – (Neoprene Pad)

A. Mason type W pads shall be bridge bearing neoprene, ¾" thick minimum. Pads shall be oil resistant.

B. Both surfaces shall be rib molded for skid resistance. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mountings to compensate for the overhang.

2.05 TYPE 3 MOUNTS – (Spring Mount)

A. Mason type SLF, combination spring and neoprene with rib molded base. Spring type isolators shall be free standing and laterally stable without any housing, and complete with 1/2" neoprene acoustical friction pads between the baseplate and the support.

B. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load.

2.06 TYPE 4 MOUNTS – (Restrained Spring Mount)

A. Mason type SLR, combination spring and neoprene with rib molded base similar to type 2 above, but shall have a housing that includes vertical limit stops to prevent springs extension when weight is removed.

B. The installed and operating heights shall be the same. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation.

2.07 TYPE S BASES – (Steel Frame)

A. Mason type WF, structural steel bases, rectangular in shape for all equipment other than centrifugal refrigeration machines and pump bases which may be "T" or "L" shaped. Pump bases for split case pumps shall include supports for suction and discharge base ells. All perimeter members shall be beams with a minimum depth equal to 1/10 of the longest dimension of the base. Beam depth need not exceed 14" provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of two inches. Example of call-out "3-S."

2.08 TYPE I BASES – (Steel Frame with Concrete)

A. Mason type K, rectangular structural beam or channel concrete forms for floating foundations. Base for split case pumps shall be large enough to provide support for suction and discharge base ells. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity.

B. Bases shall be a minimum of 1/12 of the longest dimension of base, but not less than 6". Forms shall include minimum concrete reinforcement consisting of 1/2" bars, or angles welded in place, on 6" centers running both ways in a layer 1-1/2" above the bottom or additional steel as is required by the structural conditions. Forms shall be furnished with drilled steel members with sleeves welded below the holes to receive equipment anchor bolts where anchor bolts fall in concrete locations. Height saving brackets shall be employed in all mounting locations to maintain a 2" clearance below the base. Example of call-out "3-I."

2.09 TYPE 5 HANGERS – (Spring)

A. Mason type 30N, vibration hangers with a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degrees arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.

2.10 TYPE 6 HANGERS – (Pre-compressed Spring)

A. Mason type PC30N, vibration hangers similar to type 4, but precompressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. Design hangers with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load.

2.11 TYPE 7 HANGERS – (Spring with Scale)

A. Mason type HES, a steel spring in a steel housing and include a deflection indicator scale. Hangers shall be preset at the factory for the required load. Hangers shall be capable of 130% of rated deflection, but no more than 100% of rated deflection shall be used when selecting the hanger.

B. Submittals shall include isolator rated deflection, required deflection, and supporting calculation. Calculations shall be made by a registered mechanical or civil engineer demonstrating the structural adequacy of the hanger and that its connections to the building and the pipe are adequate for the live and dead loads encountered.

2.12 TYPE 8 HANGERS – (Spring with Eye Bolts)

A. Mason type W30, a steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. Neoprene cup to contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hanger box lower hole size to be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring. Springs to have a minimum additional travel to solid equal to 50% of the rated deflection. Provide hangers with an eye bolt on the spring end and provision to attach the housing to the flat iron duct straps.

2.13 TYPE AG PIPE ANCHORS AND GUIDES

A. Shall be directional acoustical pipe anchors and guides for vertical piping consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum half inch thickness of heavy duty neoprene and duck or neoprene isolation material. Vertical restraints shall prevent vertical travel in either direction. Allowable loads on the isolation materials shall not exceed 500 psi and the design shall be balanced for equal resistance in any direction.

B. Submittals shall include supporting calculations by a registered mechanical or civil engineer indicating anchor/ guide loads and isolator selection.

C. Pipe anchors and guides for vertical piping shall be Mason type ADA or ADAH or similar by other manufacturers listed.

2.14 TYPE T THRUST RESTRAINTS

A. Mason type WB, horizontal thrust restraint consisting of a spring element in series, with a neoprene pad as described for type 2 mounts with the same deflection as specified for the mountings or hangers. The spring element shall be contained within a steel frame and designed so it can be present for thrust at the factory and adjusted in the field for a maximum of 1/4" movement at start and stop. Furnish thrust restraints complete with rods and angle brackets for

attachment to both the equipment and ductwork or equipment and structure. Attach horizontal restraints at the centerline of thrust and symmetrically on either side of the unit.

2.15 FLEXIBLE PIPING CONNECTIONS

A. Provide flexible connections for all piping to equipment mounted on vibration isolators and all piping connected to rotating or reciprocating equipment.

B. Flexible connection shall be suitable for pressure, temperature and fluid involved.

C. Minimum line length of flexible hose shall be 12" or length required to absorb 3/4" lateral movement, whichever is longer.

D. Piping connected to a coil which is in an assembly mounted on vibration isolators is to have flexible piping connections and piping vibration hangers as specified below. Piping connected to a coil which is in an assembly where the fan is separately isolated by means of vibration isolators and duct flexible connections does not require flexible piping connectors or piping vibration hangers.

E. Water and/or Pumped Condensate System:
   1. Flexible pump connectors/expansion joints shall be of the molded twin spherical type reinforced with an external root ring between spheres. Neoprene with internal steel wire, molded within the raised face ends, for added strength. Rated for minimum pressure of 225 psi at 240°F. Flanges shall be one-piece, free-floating, class 150 galvanized plate steel type with tapped or drilled holes as required. Control Units must be furnished in unanchored applications, or as recommended by the manufacturer. Flexible connectors shall be Metraflex Doublesphere or approved equal.
      a. Where extreme chemical resistance is required or short flange to flange dimensions are required, Flexible pump connectors/expansion joints shall be molded teflon bellows with flange connections and rubber isolated restraining bolts.
   2. For pumps rigidly attached to the floor, three flexible Victaulic 177/77 couplings in a row may be used in lieu of flex connector/bellow.

F. Steam and Condensate System:
   1. Seamless corrugated bronze flexible hose with braided cover for 2" and smaller and seamless corrugated stainless steel flexible hose with braided cover for 2-1/2" and larger.

G. Fuel Oil System:
   1. Seamless corrugated bronze flexible hose with braided cover.

H. Do not provide flexible piping connectors for the following systems:
   1. Refrigerant piping
   2. Gas piping

I. Engine Exhaust:
   1. Provide Bellows joint similar to Selkirk Metalbestos BJ.

2.16 PERFORMANCE

A. Select all vibration isolation devices to provide minimum 95% isolation efficiency or based on the minimum static deflection and mounting criteria listed below, whichever is greater:

Equipment Type	Floor Span							
	On Grade		20-Feet		30-Feet		40-Feet	
	Type	Min. Stat. Defl. In.	Type	Min. Stat. Defl. In.	Type	Min. Stat. Defl. In.	Type	Min. Stat. Defl. In.
Refrigeration Machines								
Absorption	2	---	4	.075	4	.075	4	1.5
Centrifugal – Open	2	---	4-S	0.75	4-S	1.5	4-S	1.5
Centrifugal -Hermetic	2	---	4	0.75	4	1.5	4	1.5
Reciprocating								
to 750 rpm	2	---	4	1.5	4-S	1.5	4-S	2.5
751 rpm & over	2	---	4	0.75	4-S	1.5	4-S	2.5
Boilers	2	0.10	4	0.75	4	0.75	4	1.5
Pumps								
Close Coupled								
through 5 hp	2-I	0.35	3-I	0.75	3-I	0.75	3-I	0.75
7 1/2 hp & over	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5
Flexible Coupled								
through 40 hp	3-I	0.75	3-I	0.75	3-I	1.5	3-I	1.5
50 hp & over	3-I	0.75	3-I	1.5	3-I	2.5	3-I	2.5
Air Cooled Condenser	2	0.35	3	0.75	3	1.5	3	2.5
Air-Cooled Condensing Units	2	0.35	4	0.75	4	1.5	4	2.5
Fan Coil Units up to 1200 CFM	-	-	1	0.35	1	0.35	1	0.35
Air Handling Units/Blower Coil								
Suspended (Hangers)								
through 5 hp	-	-	5	1.0	5	1.0	5	1.0

	7 1/2 hp & over								
	through 400 rpm	-	-	5	1.5	5	1.5	5	1.5
	401 rpm & over	-	-	5	1.0	5	1.0	5	1.5
	Floor Mounted								
-	through 5 hp	2	0.35	3	0.75	3	0.75	3	0.75
	7 1/2 hp and over								
	through 400 rpm	2	0.35	3-S	1.5	3-S	1.5	3-S	1.5
	7 1/2 HP through 40 HP								
	401 rpm & over	2	0.35	3	0.75	3	0.75	3-S	1.5
	50 HP & larger								
	401 rpm & over	2	0.35	3	0.75	3-S	1.5	3-S	2.5
Utility Sets									
	Suspended(Hangers)	-	-	5	.75	5	1.5	5	2.0
	Floor Mounted	2	.35	3	.75	3-S	1.5	3-S	2.0
	Roof Mounted	Use type 4 mount with deflection from blower minimum deflection guide up to .75" deflection. Over .75" deflection, use type 4-S mount.							
Centrifugal Blowers									
	Suspended(Hangers)	Use type 5-T hangers with deflections from blower minimum deflection guide.							
	Floor Mounted	Use type 3-I mount with deflection from blower minimum deflection guide.							
Tubular Centrifugal and Axial Fans									
	Suspended	Use type 5 hangers with deflection from blower minimum deflection guide. Use type 4-T for deflection over 4".							
	Floor mounted motor on/in fan casing	Use type 2 for .35" deflection, type 2 for .75" and type 3-S for over .75" with deflection from blower minimum deflection guide. Use type 3-S-T for deflection over 4".							
	Floor mounted arrangement - 1 or any separately mounted motor	Use 2-I for .35" deflection and 3-I for .75" and over with deflection from blower minimum deflection guide.							

Cabinet Fan and Fan Heads of Air Handling Units	
Suspended	Use type 5-T supports with deflection from blower minimum deflection guide.
Floor Mounted	Use type 2-T for .35" deflection, type 3-T for .75" deflections and 3-S-T for deflections over .75".
Cooling Tower	Use type 4 mounts with deflections from blower minimum deflection guide.
Piping connected to rotating or reciprocating equipment	Use flexible piping connections, and type 5 or 6 hangers for a distance of 100 pipe diameters or a distance of three hangers away from the equipment, whichever is greater.
Vertical pipe risers greater than 30 feet in height.	Use type 7 hangers at the top of the riser and type AG with pipe clamps at intermediate points.
Ductwork in mechanical equipment rooms.	Use type 8 hanger with .75" minimum deflection for all ducts with a cross sectional area of 2.0 square feet or over.

BLOWER MINIMUM DEFLECTION GUIDE
Required Deflection (inches)

Fan Speed (RPM)	On Grade	20' Floor Span	30' Floor Span	40' Floor Span
175-224	.35	3.5	4.5	4.5
225-299	.35	3.5	3.5	3.5
300-374	.35	2.5	2.5	3.5
375-499	.35	1.5	2.5	3.5
500 & Over	.35	.75	1.5	2.5

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with mounting and anchoring requirements for seismic installations.

B. Coordinate the selection of devices with the isolator and equipment manufacturer.

C. Isolate all motor driven mechanical equipment, unless otherwise noted, from the building structure, and from the systems which they serve, to prevent equipment vibrations from being transmitted to the structure.

D. Consider equipment weight distribution to provide uniform deflections.

E. For equipment with variable speed capability, select vibration isolation devices based on the lowest speed.

F. Install vibration isolation devices as specified, as shown on the drawings and according to the manufacturer's instructions.

G. In no case shall the installation short circuit the isolation device. Flexible piping connections are to be installed on the equipment side of shut-off valves.

END OF SECTION

SECTION 230553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Pipe labels.
   3. Pipe and equipment painting.
   4. Valve tags.

1.03 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Plastic Labels for Equipment:
   1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
   2. Letter Color: White.
   3. Background Color: Black. Red shall be used if the equipment is on emergency power.
   4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
   5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 1-1/2 inch.
   6. Minimum Letter Size: 1/2 inch Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   7. Fasteners: Stainless-steel rivets or self-tapping screws.
   8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
   9. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper, tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

B. Ceiling Grid Labels for concealed equipment and valves:
   1. Coordinate label style (e.g. Kroy/P-Touch tape, color coded dots, etc.) with architect and owner.

2.02 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.03 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
   1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. In addition to installing labels on each major item of mechanical equipment, adhesive labels shall be located on ceiling grids directly below equipment concealed in ceilings such as reheat coils, fan coil units, air handling units, VAV boxes, fire and fire/smoke dampers and other similar equipment that requires access for service. Labels shall also be installed for all branch shutoff valves.

3.03 PIPING IDENTIFICATION

A. Piping Color-Coding: Painting of piping is specified in Division 09. In the absence of specific requirements to the contrary in Division 9, all exposed equipment, piping, hangers, etc., shall be painted by the Contractor. Confirm with Owner the color scheme prior to commencing with painting. Unless otherwise directed, each system shall be painted according to the following schedule:

SYSTEM	COLOR
Chilled Water Supply & Return	Blue
Hot Water Supply & Return	Orange
Gas	Yellow

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 20 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
7. At least once in each room.

3.04 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; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

END OF SECTION

SECTION 230593

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes TAB to produce design objectives for all air and water systems including, but not limited to the following:
   1. Air Systems:
   2. Hydronic Piping Systems:
   3. HVAC equipment quantitative-performance settings.
   4. Verifying that automatic control devices are functioning properly.
   5. Reporting results of activities and procedures specified in this Section.

1.03 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise Criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room Criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 90 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration

1.05 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC or NEBB.
   1. The supervisor directly in charge of this testing shall have a TAB certificate and shall have not less than two years of experience in TAB work.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items: Include at least the following:
      a. Submittal distribution requirements.
      b. The Contract Documents examination report.
      c. TAB plan.
      d. Work schedule and Project-site access requirements.
      e. Coordination and cooperation of trades and subcontractors.
      f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems." or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

G. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 7.2.2 - "Air Balancing."

H. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.7.2.3 - "System Balancing."

1.06 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Phased TAB: The project may require startup and initial checkout to be executed in phases. This phasing will be planned and scheduled in a coordination meeting by the construction team, led by the TAB agency.

C. Renovation of Existing Systems: Where a portion of a system is not included within the Scope of Work boundary on the drawings, testing of the entire existing affected systems are required prior to construction. The first test shall establish existing water and air flows to sub-mains, branches and run-outs to areas which are not scheduled for renovation. The final test shall reset flows of water and air to sub-mains, branches and run-outs outside renovated area to the recorded values from the first test. Include total capacity test of any scheduled existing equipment. Include flow test results of first and final balancing of existing systems in final report.

1.07 DEFICIENCIES

A. Any deficiency in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible Contractor or person.

B. The work necessary to correct items on the deficiency list shall be performed and verified by the affected contractor or sub-contractor before the TAB agency returns to retest.

C. The TAB agency shall return to the site to readjust systems that do not test within specified requirements.

1.08 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.09 WARRANTY

A. Special Guarantee: Provide a guarantee on national certifying agency forms stating that the national certifying agency will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
   1. The certified TAB firm has tested and balanced systems according to the Contract Documents.

2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
   1. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6 and/or ASHRAE “Fundamentals Handbook” Duct Design Chapter. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. Sequence of operation for control modes is according to the Contract Documents.
   8. Controller set points are set at indicated values.
   9. Interlocked systems are operating.
   10. Changeover from heating to cooling mode occurs according to indicated values.

S. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.02 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Hydronic systems are filled, clean, and free of air.
   3. Automatic temperature-control systems are operational.
   4. Equipment and duct access doors are securely closed.
   5. Balance, smoke, and fire dampers are open.
   6. Isolating and balancing valves are open and control valves are operational.
   7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 TAB CONSTRUCTION ADMINSTRATION SERVICES

A. Project Site Observations: During construction, the TAB agency shall observe the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems. Provide a minimum of two site observations when HVAC systems are approximately 50% and 80% complete and issue Field Reports indicating observations and noted deficiencies.

3.04 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in the TAB firm's national certifying agency: AABC or NEBB; and this section.
   1. Comply with requirements in ASHRAE 62.1-2007, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

3.05 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

M. Fans with Adjustable Speed Drives should be provided with the largest non-overloading sheaves available to match the “full speed” of the motor in Bypass or Hand mode of the Drive.

N. For constant speed fans, after the system is balanced, fixed pitch sheaves shall replace the variable pitch sheaves for all motors using multiple belt drives.

O. Outside Air. Test and adjust the outside air on applicable equipment. Outside air damper percent open shall be documented and provided to BAS contractor.

P. Fan Static Pressure Profile. Provide a diagram of each fan and air handling unit showing the static pressure profile through each pressure drop device (coil, damper, fan, coil, dampers, etc)

Q. Energy Efficiency Balancing Approach: At least one run-out volume damper shall be full open in efforts to provide an energy efficient balanced system.

R. Room Airflow Tolerance. While the air outlet tolerances are +/- 10%, the Room total air balance shall also be within 10% of the scheduled room air flow.

S. Provide duct smoke detector air differential pressure test for each duct detector in accordance with the manufacturer’s instructions to insure detectors have been properly installed. Contractor shall correct any deficient installation and TAB agency shall retest.

3.06 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 fan static pressures to determine actual static pressure as follows:
      a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
      b. Measure static pressure directly at the fan outlet or through the flexible connection.

c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and air-treating equipment.
   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Make required adjustments to pulley/sheave sizes, motor sizes, and electrical connections to accommodate fan-speed changes. Replace pulley/sheaves to provide the required fan rpm.
6. 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 modes to determine the maximum required brake horsepower (kW).

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
   1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.
   1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using 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.

E. CAV System Static Pressure Control:
   1. After balancing the terminal units of the system, simulate the dirty filter pressure drop conditions.
   2. Work with the controls contractor to set the fan pressure control tracking setpoint to maintain the specified flow. Record in the TAB report the static pressure requirement at the static pressure sensor. Optimize the balancing so the static pressure setpoint is as low as possible to achieve airflow at the furthest diffuser with simulated dirty filter pressure drop.
   3. Record the fan adjustable speed drive speeds at both the clean and dirty filter conditions. Note that the fan shall be sheaved so the adjustable speed drive should be less than 100% at dirty filter conditions.

F. Economizer Systems:

1. Balance the supply air side according to CAV procedures using minimum outdoor air volumes. Record the balanced system return duct static pressure at the control system sensor.
2. For CAV systems the design intent is for the exhaust/return fan speed to modulate to maintain the return duct static pressure setpoint.
3. The control contractor should turn the AHU system to full economizer mode, using 100% outside air. During this mode the exhaust/return fan sheaves and fan adjustable speed drive should be set up so the adjustable speed drive is no more than 90%. This will leave 10% spare capacity for future adjustments.
4. Part Load Performance: Record duct static pressures and fan speeds for outdoor air volumes of 100%, 75%, 50%, and 25%

3.07 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point 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 outside-air dampers at minimum, and 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 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 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 as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
   6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
   7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
   8. Record the final fan performance data.

C. Economizer Systems:
   1. Balance the supply air side according to VAV procedures using minimum outdoor air volumes. Record the balanced system return duct static pressure at the control system sensor.
   2. For VAV systems, the design intent is for the exhaust/return fan speed to modulate to maintain a slight positive (0.02” wg (3 Pa)) building or common space static pressure setpoint.
   3. The control contractor should turn the AHU system to full economizer mode, using 100% outside air. During this mode the exhaust/return fan sheaves and fan adjustable speed drive

should be set up so the adjustable speed drive is no more than 90%. This will leave 10% spare capacity for future adjustments.

4. Part Load Performance: Record duct static pressures and fan speeds for outdoor air volumes of 100%, 75%, 50%, and 25%.

3.08 PROCEDURES FOR MULTIZONE SYSTEMS

A. Set unit at full flow through the cooling coil if coil has that capacity.

B. Adjust each zone damper to indicated airflow.

3.09 GENERAL PROCEDURES FOR SYSTEM BALANCING WITH AIR FILTERS

A. For supply or exhaust systems with filters, the systems shall be balanced with clean filters, then re-tested with simulated dirty filter pressure drop conditions.

B. Dirty Filter Simulation: Use a filter area blank off plate made of cardboard or plastic to simulate the dirty filter pressure drop.

C. Document main traversed air flows with both clean and dirty filter pressure drops.

D. Coordinate with Contractor to replace the construction filters with new filters prior to TAB.

E. If not provided in the Contract Documents, use the following values for dirty filter pressure drops.

Filter	Assumed Clean DP	Dirty DP
30% Pre (flat)	0.2”	0.4”
30% Pre (angled)	0.25”	0.5”
>60%	0.5”	1.0”
>90%	0.75”	1.5”
99%	0.75”	1.5”

3.10 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check expansion tank liquid level, and bladder pre-charge pressure.
3. Check makeup-water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.11 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
3. Verify pump-motor brake horsepower (kW). Calculate the intended brake horsepower (kW) for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated pre-settings.
1. For Pressure Independent Flow Control valves (flow limiting valves), measure and verify that the differential pressure is in the proper range for the valve capability. Verify the maximum flow through a minimum of 5 valves in the system, preferably nearest to the pump with the highest system pressure.
2. For Pressure Independent Characterized Control Valves (PICCV), measure and verify that the differential pressure is in the proper range for the valve capability. Verify the maximum flow through 5 valves in the system. Verify the control voltage for ‘closed’ (usually 0V) actually closes the valve to water flow.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.12 PROCEDURES FOR PUMP BALANCING

A. Constant Speed Pumps. Coordinate constant speed pump impeller trimming so that the pump will provide 110% of design flow with the balancing valve at the pump wide open. After trimming, the balancing valve shall be adjusted to provide the designed flow rate. This will leave 10% spare safety capacity. The pump specification requires a spare impeller for all pumps. TAB technician to provide impeller trimming diameter requirements to the mechanical contractor. The spare impeller shall be shaved to proper dimensions, then it shall replace the original impeller, and the original full-size impeller shall become the spare.

B. Variable Speed Pumps.
1. Impellers. Pumps on adjustable speed drives should be provided with the largest non-overloading impellers available; all balancing should be done via the adjustable speed drives.
2. DP Setpoint. Set pump differential pressure control tracking setpoint to maintain flow at design diversity established. Record in the TAB report the pressure requirement at the differential pressure sensor. The expected range of the DP setpoint is 5 psi to 10 psi at the most hydraulically remote piece of equipment. If static pressure reset strategy is used, record the average plant DP setpoint.
3. Manual Valves at Devices. For manual balancing valves in the variable flow systems, manually set the overall system to 25% design flow by closing control or manual valves to coils. Retest 20% of the coils closest to the pump and readjust the manual balance valves to

achieve design flow with full flow through that coil. The readjusted setting shall be the final setting for those coils. This approach ensures design flow through the device at low system flow, and assumes a local overflow situation at higher system flows.

4. Full Flow Test. Coordinate with BAS to override all water valves to full open position. Ensure the pump adjustable speed drive speed is less than 100% and the DP setpoint is maintained. If this test fails, then rebalancing will be required.

3.13 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.14 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

A. Balance the primary system crossover flow first, then balance the secondary system.

3.15 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP (0.37 kW) and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer, model, and serial numbers.
   2. Motor horsepower (kW) 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 for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.16 PROCEDURES FOR BOILERS

A. Hydronic Boilers:
   1. Measure and record entering- and leaving-water temperatures.
   2. Measure and record water flow.
   3. Record relief valve pressure setting If hydronic, measure entering- and leaving-water temperatures and water flow.

B. Steam Boilers:
   1. Measure and record entering-water temperature.
   2. Measure and record feed water flow.
   3. Measure and record leaving-steam pressure and temperature.
   4. Record relief valve pressure setting.

3.17 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:
   1. Entering- and leaving-water temperature.
   2. Water flow rate.
   3. Water pressure drop.
   4. Dry-bulb temperature of entering and leaving air.
   5. Wet-bulb temperature of entering and leaving air for cooling coils.
   6. Airflow.
   7. Air pressure drop.

B. Electric-Heating Coils: Measure the following data for each coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Refrigerant Coils: Measure the following data for each coil:
1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

D. Manual Balancing Valves (pressure dependent valves): Measure the following data for each coil or device:
1. Valve type
2. Location
3. Valve differential pressure reading
4. Coil pressure drop
5. GPM (L/sec)

E. Pressure Independent Flow Control Valves: Measure the following data for each valve:
1. Valve type
2. Location
3. Valve differential pressure reading
4. Factory differential pressure control range, and verify the valve is within pressure tolerance

3.18 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. For Air Handling Units: Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied. This can be accomplished thru the Building Automation System.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.19 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Check main control supply-air pressure and observe compressor and dryer operations.

J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.20 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 percent to plus 10 percent. This includes duct distribution loss.
   2. Air Outlets and Inlets: Plus 10 percent to minus 10 percent, as long as the overall room is balanced properly and room minimum code required total air changes per hour are maintained.
   3. Heating-Water Flow Rate: Plus 10 percent to minus 10 percent.
   4. Cooling-Water Flow Rate: Plus 10 percent to minus 10 percent.
   5. Generation Equipment (chillers, boilers, etc) should be balanced as close as possible to the accuracy of the measuring equipment.
   6. Fume Hood and Biosafety Cabinet airflows should be balanced as close as possible to the accuracy of the measuring equipment.

3.21 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.22 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
   1. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.

9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils if applicable.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Settings for supply-air, static-pressure controller.
    g. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outside, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
    j. Number of belts, make, and size.
    k. Number of filters, type, and size.
2. Motor Data:
    a. Make and frame type and size.
    b. Horsepower (KW) and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
3. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.

f. Preheat coil static-pressure differential in inches wg.
g. Cooling coil static-pressure differential in inches wg.
h. Heating coil static-pressure differential in inches wg.
i. Outside airflow in cfm.
j. Return airflow in cfm.
k. Outside-air damper position.
l. Return-air damper position.

F. Apparatus-Coil Test Reports:
1. Coil Data:
a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outside-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btuh.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower (kW) and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Sheave dimensions, center-to-center, and amount of adjustments in inches.
2. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.

b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btuh.
i. High-fire fuel input in Btuh.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btuh.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btuh.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
1. Unit Data:
a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btuh.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.
2. Test Data (Indicated and Actual Values):
a. Heat output in Btuh.
b. Airflow rate in cfm.
c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
2. Motor Data:
a. Make and frame type and size.
b. Horsepower (KW) and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
    a. System and air-handling unit number.
    b. Location and zone.
    c. Traverse air temperature in deg F.
    d. Duct static pressure in inches wg.
    e. Duct size in inches.
    f. Duct area in sq. ft..
    g. Indicated airflow rate in cfm.
    h. Indicated velocity in fpm.
    i. Actual airflow rate in cfm.
    j. Actual average velocity in fpm.
    k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:
1. Unit Data:
    a. System and air-handling unit identification.
    b. Location and zone.
    c. Test apparatus used.
    d. Area served.
    e. Air-terminal-device make.
    f. Air-terminal-device number from system diagram.
    g. Air-terminal-device type and model number.
    h. Air-terminal-device size.
    i. Air-terminal-device effective area in sq. ft..
2. Test Data (Indicated and Actual Values):
    a. Airflow rate in cfm.
    b. Air velocity in fpm.
    c. Preliminary airflow rate as needed in cfm.
    d. Preliminary velocity as needed in fpm.
    e. Final airflow rate in cfm.
    f. Final velocity in fpm.
    g. Space temperature in deg F.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
    a. System and air-handling unit identification.
    b. Location and zone.
    c. Room or riser served.
    d. Coil make and size.
    e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
    a. Airflow rate in cfm.
    b. Entering-water temperature in deg F.
    c. Leaving-water temperature in deg F.
    d. Water pressure drop in feet of head or psig.
    e. Entering-air temperature in deg F.

f. Leaving-air temperature in deg F.

M. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Unit make and model number.
      d. Compressor make.
      e. Compressor model and serial numbers.
      f. Refrigerant weight in lb.
      g. Low ambient temperature cutoff in deg F.
   2. Test Data (Indicated and Actual Values):
      a. Inlet-duct static pressure in inches wg.
      b. Outlet-duct static pressure in inches wg.
      c. Entering-air, dry-bulb temperature in deg F.
      d. Leaving-air, dry-bulb temperature in deg F.
      e. Condenser entering-water temperature in deg F.
      f. Condenser leaving-water temperature in deg F.
      g. Condenser-water temperature differential in deg F.
      h. Condenser entering-water pressure in feet of head or psig.
      i. Condenser leaving-water pressure in feet of head or psig.
      j. Condenser-water pressure differential in feet of head or psig.
      k. Control settings.
      l. Unloader set points.
      m. Low-pressure-cutout set point in psig.
      n. High-pressure-cutout set point in psig.
      o. Suction pressure in psig.
      p. Suction temperature in deg F.
      q. Condenser refrigerant pressure in psig.
      r. Condenser refrigerant temperature in deg F.
      s. Oil pressure in psig.
      t. Oil temperature in deg F.
      u. Voltage at each connection.
      v. Amperage for each phase.
      w. Kilowatt input.
      x. Crankcase heater kilowatt.
      y. Number of fans.
      z. Condenser fan rpm.
      aa. Condenser fan airflow rate in cfm.
      bb. Condenser fan motor make, frame size, rpm, and horsepower (kW).
      cc. Condenser fan motor voltage at each connection.
      dd. Condenser fan motor amperage for each phase.

N. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Service.
      d. Make and size.
      e. Model and serial numbers.
      f. Water flow rate in gpm.
      g. Water pressure differential in feet of head or psig.

h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower (kW) and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

O. Boiler Test Reports:
1. Unit Data:
a. Unit identification.
b. Location.
c. Service.
d. Make and type.
e. Model and serial numbers.
f. Fuel type and input in Btuh.
g. Number of passes.
h. Ignition type.
i. Burner-control types.
j. Voltage at each connection.
k. Amperage for each phase.

2. Test Data (Indicated and Actual Values):
a. Operating pressure in psig.
b. Operating temperature in deg F.
c. Entering-water temperature in deg F.
d. Leaving-water temperature in deg F.
e. Number of safety valves and sizes in NPS.
f. Safety valve settings in psig.
g. High-limit setting in psig.
h. Operating-control setting.
i. High-fire set point.
j. Low-fire set point.
k. Voltage at each connection.
l. Amperage for each phase.
m. Draft fan voltage at each connection.
n. Draft fan amperage for each phase.
o. Manifold pressure in psig.

P. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.

b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.23 GAUGE AND SENSOR ACCURACY VALIDATION

A. The accuracy of the project's installed gauges, thermometers and sensors shall be validated by the TAB Contractor. The TAB Contractor shall use calibrated gauges and thermometers and compare the values against the contractor installed gauges, thermometers and sensors.

1. Pressure gauges and BAS sensors – Water Systems
   a. The installed pressure gauges shall be within 2 psi (14 kPa) or 5% of the TAB contractors calibrated gauge at the normal system operating pressure.
   b. TAB shall notify the Mechanical Contractor of any gauge deficiency, for the gauge to be recalibrated or replaced.
   c. Replaced gauges shall be verified for accuracy by TAB.
2. Thermometers and BAS sensors – Water Systems
   a. The installed thermometers and sensors shall be within the following tolerances of the TAB contractor's calibrated temperature range at normal system operating temperatures:
      1) Chilled water: 0.5ºF (0.25ºC)
      2) Hot Water: 2.0ºF (1.0ºC)
      3) Condenser Water: 0.5ºF (0.25ºC)
      4) Heat Pump or process: 2ºF
   b. TAB shall work with the BAS contractor to calibrate sensors.
   c. TAB shall notify appropriate responsible contractor of gauge or sensor deficiency for the above to be re-calibrated or replaced.
   d. Replaced gauges shall be verified for accuracy by TAB.
3. Flow Meters – Water Systems
   a. After the flow meter has been set up and calibrated by the manufacturer's representative, the TAB contractor shall validate the flow by using ultrasonic flow measuring equipment. The flow meters shall be within 5% flow of the TAB contractor's calibrated equipment measurement.
   b. TAB shall notify appropriate responsible contractor of the flow meter accuracy deficiency for the flow meter to be re-calibrated or replaced.
4. Pressure Gauges and BAS Sensors – Air Systems
   a. The installed pressure gauges and BAS pressure sensors shall be within 10% of the TAB contractor's calibrated gauge at the normal operating pressures.
   b. TAB shall notify the responsible contractor of gauge or sensor deficiency for the above to be re-calibrated or replaced.
   c. Replaced gauges shall be verified for accuracy by TAB.
   d. The following are the tolerances for various pressure gauges and sensors:
      1) Filters: +/- 10%
      2) Duct: +/- 10%
      3) Space: +/-0.01"
      4) Isolation Room: +/- 0.001" wg
5. Thermometers and BAS Sensors – Air Systems
   a. The installed duct thermometers shall be within 1F of the TAB contractors calibrated gauge.
   b. Duct or air handling unit mounted BAS sensors shall be within 1F of TAB contractor's calibrated gauge. This includes OA, MA, coil, leaving air, and return air sensors.
   c. TAB shall notify responsible contractor of accuracy deficiency, for the device to be recalibrated or replaced.
6. Air Flow Measuring Stations
   a. The TAB Contractor shall validate the accuracy of air flow measuring stations by taking traverse readings. The accuracy shall be within 5%.

b. TAB shall notify responsible contractor of accuracy deficiency for the device to be recalibrated or replaced.

3.24 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
   2. Randomly check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure water flow of at least 5 percent of terminals.
      c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      d. Measure space pressure of at least 10 percent of locations.
      e. Verify that balancing devices are marked with final balance position.
      f. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
   1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner or Architect.
   2. TAB firm test and balance engineer shall conduct the inspection in the presence of Owner or Architect.
   3. Owner or Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
   4. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
   5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
   6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
   7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

C. Authority Having Jurisdiction Inspection
   1. Attend inspection by AHJ. A completed and approved certified copy of the TAB report shall be available at the project site at the AHJ inspection. This includes AHCA and OSHPD inspections.

3.25 DEFICIENCY RESOLUTION

A. As testing progresses and a deficiency is identified, the TAB contractor shall coordinate with the Contractors to identify the deficiency for a timely resolution of the deficiency.

B. The TAB contractor shall include in their base bid, the initial test adjust balance, plus returning to the site for two additional visits to retest systems that do not test within specification requirements. Any additional testing requirements will fall under requirements listed under Cost of Retesting.

C. Cost of Retesting

1. The cost for any additional testing beyond the requirements in the paragraph above shall be borne by the installing Contractors, if they are responsible for the deficiency. If they are not responsible, then reasonable costs for retesting shall be negotiated with the Contractor.
2. The time for the Architect/Engineer to direct any retesting required because a specific system report to have been successfully completed, but determined during testing to be faulty, will be back-charged to the Contractor, who may choose to recover costs from the party responsible for stating the system was complete and ready for testing.

D. Failure Due to Manufacturer Defect: If 10%, or three (whichever is greater), of identical pieces (size does not constitute a difference) of equipment fails to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance, then all identical units may be considered unacceptable by the TAB agency or the Architect/Engineer. In such case, the Contractor shall provide the Owner with the following:
1. Within one week of notification from the TAB agency, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the Architect/Engineer within two weeks of the original notice.
2. Within two weeks of the original notification, the Contractor or manufacturer's representative shall provide a signed and dated written explanation of the problem, cause of failures, etc., and proposed solutions which shall include full equipment submittals. The propose solutions shall not significantly exceed the specification requirements of the original installation.
3. The Architect/Engineer will determine whether a replacement of all identical units or a repair is acceptable.
4. The proposed solution will be installed by the Contractor, and tested for up to one week, upon which the Architect/Engineer will decide whether to accept the solution.
5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

3.26 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, then the TAB contractor shall return to perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.
1. Air handler coil performance test shall be recorded during the opposite season.
2. To verify system calibration, control and operation, test and record 25% of the previously recorded room temperatures (dry bulb and wet bulb). Measurements shall be made near each room sensor or thermostat location in each separate controlled zone. The resulting temperature data shall be included in a revised report with associated thermostat or control setpoint during the tests. Outside temperature and humidity conditions shall also be recorded during the testing periods.
3. Areas of verification include: economizer airflows, building or space pressurization, coil leaving air temperature accuracy.

3.27 SPACE TEMPERATURE AND HUMIDITY VERIFICATION

A. For hotel guestrooms, apartment units and condo units, provide one week of temperature and humidity data for a guestroom, apartment or condo unit on each floor. This can be achieved through the Building Automation System or by the use of data loggers.

END OF SECTION

SECTION 230700

HVAC INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Calcium silicate.
      b. Cellular glass.
      c. Flexible elastomeric.
      d. Mineral fiber.
      e. Phenolic.
      f. Polyisocyanurate.
   2. Fire-rated insulation systems.
   3. Insulating cements.
   4. Adhesives.
   5. Coatings/Mastics.
   6. Lagging adhesives/coatings.
   7. Sealants.
   8. Factory-applied jackets.
   9. Field-applied fabric-reinforcing mesh.
   10. Field-applied cloths.
   11. Field-applied jackets.
   12. Tapes.

B. Related Sections:
   1. Division 21 Section "Fire-Suppression Systems Insulation."
   2. Division 22 Section "Plumbing Insulation."
   3. Division 23 Section "Metal Ducts" for duct liners.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer of insulation product used.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports

1.05 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and

jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 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.

1.07 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.08 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

2.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Industrial Insulation Group (The); Thermo-12 Gold.
      b. Pabco Super Caltemp
   2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Cellular Glass: 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 one of the following:
      a. Cell-U-Foam Corporation; Ultra-CUF.
      b. Owens Corning Corporation; Foamglas One.
   2. Block Insulation: ASTM C 552, Type I.
   3. Special-Shaped Insulation: ASTM C 552, Type III.
   4. Board Insulation: ASTM C 552, Type IV.
   5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
   6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
   7. Prefabricate insulation for valves, elbows, tees, flanges and other fittings.

H. Flexible Elastomeric: Closed-cell expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc..
      b. Armacell LLC.
      c. K-Flex
   2. Flame spread and smoke developed index of 25/50 per ASTM E84.
   3. Unslit or slit type with self- sealing factory installed tape with overlapping longitudinal seam seal as required to suit the installation.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of 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.

J. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB with factory applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Commercial Board.
      b. Fibrex Insulations Inc.; FBX.
      c. Johns Manville; 800 Series Spin-Glas.
      d. Knauf Insulation; Insulation Board.
      e. Manson Insulation Inc.; AK Board.
      f. Owens Corning; Fiberglas 700 Series.

K. Mineral-Fiber, Preformed Pipe Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type IV with factory applied ASJ jacket suitable for piping systems operating at temperatures up to 1000 deg F.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville.
      b. Knauf Insulation.
      c. Manson Insulation Inc.
      d. Owens Corning.

L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or

Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

M. Phenolic:

1. Products: Subject to compliance with requirements, provide the following :
   a. ITW “Illinois Tool Works”.; Trymer Green
   b. Kingspan Corp.; Koolphen K.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

N. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Apache Products Company; ISO-25.
   b. ITW “Illinois Tool Works”.; Trymer 2000XP
   c. Duna USA Inc.; Corafoam.
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 at 75 deg F after 180 days of aging.
3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1 inch as tested by ASTM E 84. Thicknesses greater than 1 inch are not allowed unless documentation is submitted showing a smoke developed index of 50 or less.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

2.02 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, provide the following :
   a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   c. Thermal Ceramics; FireMaster Duct Wrap.
   d. 3M; Fire Barrier Wrap Products.
   e. Unifrax Corporation; FyreWrap

2.03 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

2.04 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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, H. B. Fuller Construction Products; CP-97.
      b. Foster Products, H. B. Fuller Construction Products; 81-27.

C. Cellular-Glass, Phenolic and Polyisocyanurate 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, H. B. Fuller Construction Products; CP-96.
      b. Foster Products Corporation, H. B. Fuller Construction Products; 81-33.

D. Flexible Elastomeric Adhesive:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Foster Products, H. B. Fuller Construction Products; 85-75
      b. K-Flex, 373

E. Mineral-Fiber Adhesive: Comply with ASTM C 916 Type I/II.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, H. B. Fuller Construction Products; CP-127/CP-82.
      b. Foster Products, H. B. Fuller Construction Products; 85-60/85-20.

F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with ASTM C 916 Type I/II for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, H. B. Fuller Construction Products; CP-127/CP-82.
      b. Foster Products Corporation, H. B. Fuller Construction Products; 85-60/85-20.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.05 COATINGS/MASTICS

A. Vapor-Barrier Coating: Mold Resistant, water based; suitable for indoor and outdoor use on below ambient services. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II and must be QPL listed
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Foster Products, H. B. Fuller Construction Products; 30-80 AF.
   2. Must comply with ASTM D 5590 with 0 growth rating.
   3. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 permat 43-mildry film thickness.
   4. Service Temperature Range: Minus 20 to plus 180 deg F.

B. Vapor-Barrier Coating: Solvent based; suitable for outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products; H.B. Fuller Construction Products; Encacel V/VI.
      b. Foster Products; H.B. Fuller Construction Products; 60-95/60-96.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   3. Service Temperature Range: Minus 50 to plus 220 deg F.
   4. Solids Content: ASTM D 1644, 33 percent by volume and 46 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 one of the following:
   a. Childers Products; H.B. Fuller Construction Products; CP-10/CP-11.
   b. Foster Products; H.B. Fuller Construction Products; 46-50.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White

2.06 LAGGING ADHESIVES/COATINGS

A. Description: Mold resistant. Shall be compatible with insulation materials, jackets, and substrates.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, H. B. Fuller Construction Products; CP-137 AF.
      b. Foster Products, H. B. Fuller Construction Products; 30-36 AF.
   2. Must comply with ASTM D 5590 with 0 growth rating.
   3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
   4. Service Temperature Range: Minus 50 to plus 180 deg F.

2.07 SEALANTS

A. Joint Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following
      a. Childers Products, H. B. Fuller Construction Products; CP-76/CP-70.
      b. Foster Products, H. B. Fuller Construction Products; 30-45/95-50.
      c. Pittsburgh Corning Pittseal 444N or 727
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, sealant.
   4. Service Temperature Range: Minus 100 to plus 200 deg F.
   5. Color: White, gray, tan, or aluminum

B. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, H. B. Fuller Construction Products; CP-76/CP-70.
      b. Foster Products, H. B. Fuller Construction Products; 95-44/30-45.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible, sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Gray or Aluminum

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide the following :
      a. Childers Products, H. B. Fuller Construction Products; CP-76/CP-70.
      b. Foster Products, H.B. Fuller Construction Products; 95-44/30-45.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Fire- and water-resistant, flexible sealant.
   4. Service Temperature Range: Minus 40 to plus 250 deg F.
   5. Color: Gray or Aluminum

2.08 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.

2.09 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. Childers Chil Glas #10
   2. Vimasco 894

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 0.9 oz/sq. yard. with a thread count of 9 strands by 8 strands/sq. inchfor covering equipment.
   1. Foster Mast A Fab

2.10 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: Color as selected by Architect.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   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. Sheet and roll stock ready for shop or field sizing.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor or Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
   3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
      a. Sheet and roll stock ready for shop or field sizing.
      b. Material, finish, and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor and outdoor applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pittsburgh Corning Corporation; Pittwrap.
      b. Polyguard; Insulwrap No Torch 125.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 11.5 mils.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Width: 2 inches.
   2. Thickness: 6 mils.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Install joint sealant for all longitudinal and butt joints.

K. Insulation is required for all systems and equipment operating below 70 F and above 105 F.

L. 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.

M. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

N. 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 fab and mastic to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

O. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

P. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

Q. 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.

R. 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.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

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. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."
4.

3.05 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 and 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. 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. 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.
5. 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.
6. 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.

7. For services not specified to receive a field-applied jacket except for flexible elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
8. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, 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.

3.06 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Boiler Breechings, Ducts, Straight Pipes, and Tubes:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.07 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.

3.08 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.

3.09 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. Blanket or Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers insulation surface. Cover exposed pins and washers with fab and mastic.
4. For all ducts and plenums, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    a. Repair punctures, tears, and penetrations with mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. All joints, seams and punctures shall be sealed with fabric and mastic. Secure laps to adjacent insulation section with 1/2-inchoutward-clinching staples, 6 inches (150 mm) o.c. Cover all joints, seams and punctures with minimum 3” wide glass cloth cloth fabric set in mastic. After first coat is dry, apply second coat of mastic.
7. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
8. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.10 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.

3.11 POLYISOCYANURATE INSULATION INSTALLATION

A. Installation near fire resistance rated barriers.
   1. Polyisocyanurate insulation is not allowed where penetrations pass through a fire resistance rated barrier. Another type of insulation must be used within 10 feet of any fire resistance rated barriers.

B. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation to pipe with tape or bands and tighten 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.

3.12 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 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.

C. 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.

3.13 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.14 FINISHES

A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

B. Do not field paint aluminum or stainless-steel jackets.

3.15 DUCT INSULATION SCHEDULE, GENERAL

A. Ductwork insulation includes all apparatus casings such as air terminal devices, duct heating coils, filters, mixing chambers, sound attenuators, etc., which shall be insulated in accordance with applicable ductwork insulation specifications.

B. Plenums and Ducts Requiring Insulation:
   1. Indoor, concealed supply, return, and outdoor air.

2. Indoor, exposed supply, return, and outdoor air.
3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
4. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
5. Outdoor, concealed supply and return.
6. Outdoor, exposed supply and return.

C. Items Not Insulated:
1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.16 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Unconditioned spaces shall be considered to be outdoors.

B. Concealed supply-air, return-air, and outside-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Exposed supply-air, return-air, and outside-air duct and plenum insulation shall be one of the following:
1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

3.17 ABOVEGROUND, EXTERIOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Round and flat-oval, supply-air, return-air, and outside-air duct insulation shall be one of the following:
1. Mineral-Fiber Blanket: 3 inches and 0.75-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 3 inches thick and 3-lb/cu. ft. nominal density.

C. Rectangular, supply-air, return-air, exhaust-air, and outside-air duct and plenum insulation shall be one of the following:
1. Cellular Glass: 3 inches thick.
2. Polyisocyanurate: 3 inches thick.

3.18 DIFFUSER PLENUMS, BACKS AND NECKS INSULATION SCHEDULE

A. Insulate the back of supply diffusers, diffuser plenums and necks of diffusers with the same insulation material and thickness as specified for the ductwork system it is connected to.

3.19 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. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

C. For piping exposed to outdoor air, increase the thickness shown in the schedule below by ½" (in.).

3.20 PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1/2 inch thick.

B. Heating-Hot-Water Supply and Return,:
   1. Pipe sizeNPS 1 1/4and smaller: Insulation shall be one of the following:
      a. Cellular Glass: 1 1/2 inches. thick
      b. Mineral-Fiber, Preformed Pipe: 1 1/2 inchesthick. Use limited to interior applications only.
      c. Phenolic: 1 inch thick. Use limited to exterior above ground applications only.
   2. Pipe size larger thanNPS 1 1/4: Insulation shall be one of the following:
      a. Cellular Glass: 2 inches. thick
      b. Mineral-Fiber, Preformed Pipe: 2 inches thick. Use limited to interior applications only.
      c. Phenolic: 1 inch thick. Use limited to exterior above ground applications only.

C. Refrigerant Suction and Hot-Gas Bypass Piping (If Used):
   1. Flexible Elastomeric: 1inch thick.
      a.

3.21 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:
   1. None.

D. Ducts and Plenums, Exposed:
   1. None.

E. Piping, Concealed:
   1. None.

F. Piping, Exposed:
   1. Within 6 feet A.F.F. PVC: 30 mils thick.

3.22 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums,:
   1. Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.016 inch thick.

D. Piping and Equipment:
   1. Stainless Steel, Type 304 or 316, Stucco Embossed: 0.016 inch thick.

END OF SECTION

SECTION 230800

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
   1. Refer to Division 01 Section "General Commissioning Requirements" for commissioning process requirements applicable to Division 23.
   2. International Building Code – Energy Conservation, Section C403, C405 and C408
   3. California Mechanical Code 2019
   4. California Energy Code 2019
   5. California Title 24

1.02 SUMMARY

A. This section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies or components.

B. The following systems/equipment shall be commissioned:
   1. Plumbing – Division 22; Service Water Heating System including solar systems and associated controls.
   2. HVAC – Division 23; HVAC Equipment, Building Automation System (BAS), Test Adjust and Balance – Air/Water.
      a. Unitary or packaged HVAC equipment listed in Table C403 for that do not require supply air economizers are exempt from commissioning.
   3. Electrical - Division 26; Controls for Automatic Lighting Systems.

C. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning project. Commissioning is essentially a quality management process of observing and documenting that the equipment and systems operate and perform as intended.

D. The commissioning testing shall be based upon the following reference standards: Building Commissioning Association (www.bCxP.org); ASHRAE Guideline 0-2005, The Commissioning Process.

1.03 DEFINITIONS

A. Abbreviations: The following are common abbreviations:
   1. A/E – Architect and design engineers
   2. Cx – Commissioning
   3. CxP – Commissioning Provider
   4. Cx Plan – Commissioning Plan document
   5. FPT – Functional-Performance Test
   6. GC – General Contractor
   7. HVAC – Heating, Ventilation, and Air Conditioning
   8. IST – Integrated Systems Test
   9. TAB – Test, Adjust, and Balance

B. Cx Plan: A document that provides the following:
   1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
   2. A listing of the specific equipment, appliances or systems to be tested and a description of the tests to be performed.
   3. Functions to be tested including, but not limited to, calibrations and economizer controls.

4. Conditions under which the test will be performed including but not limited to winter and summer design conditions and full outside air conditions.
5. Measurable criteria for performance.

C. Preliminary Commissioning Report – A preliminary report of commissioning test procedures and results prepared and certified by a licensed design professional, electrical engineer, mechanical engineer or approved agency, and is provided to the building owner or owner's authorized agent. The report, organized with mechanical and service hot water and lighting in separate sections includes at a minimum, the following:
1. Itemization of deficiencies found during testing that have not been corrected at the time of the report.
2. Deferred tests that cannot be performed at the time of the report preparation because of climatic conditions.
3. Climatic conditions required for performance of the deferred tests.
4. Results of functional performance tests.
5. Functional performance test procedures used during the commissioning process, including measurable criteria for test acceptance.

D. Final Commissioning Report – A report of final test procedures and results identified which is provided to the building owner or owner's authorized agent. The report, organized with mechanical and service hot water and lighting in separate sections includes at a minimum, the following:
1. Results of functional performance tests.
2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance.
4. Deferred tests that cannot be performed at the time of the report preparation because of climatic conditions.

E. CxP: Commissioning Provider/Person(s) that directs and coordinates the commissioning activities.

F. FPT: Test that verifies the proper operation of equipment or system. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state including performance of all alarms and operator user interfaces. Tests also require operation under various modes, such as during low cooling or heating loads, part loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, restoration of power, redundant or automatic back-up mode, etc.

G. IST: Test intended to supplement the Functional-Performance Tests and to specifically address equipment interoperation, systems interoperation, design space loading, failure scenarios and/or overall system survivability. Completion of associated Functional-Performance Tests is required prior to execution of IST(s).

H. Seasonal Tests: Tests that are deferred until the system(s) will experience outdoor weather conditions closer to their design conditions. Trend data from the building automation system contractor may be used to evaluate equipment performance for seasonal testing.

1.04 QUALIFICATIONS

A. There are no qualifications required of the mechanical contractor.

1.05 SUBMITTALS

A. There are no qualifications required of the mechanical contractor.

1.06 COMMISSIONING PROVIDER

A. The Commissioning Provider shall be provided by the Division 1 Contractor. The contractor and sub-contractors are responsible to execute the commissioning process according to this Section.

1.07 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives from the Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxP.

B. Members Appointed by Owner:
   1. CxP: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxP under a separate contract.
   2. Representatives of the facility user and operation and maintenance personnel.
   3. Architect and engineering design professionals.

1.08 RESPONSIBILITY MATRIX

A. The following responsibility matrix outlines the major tasks of the commissioning process and the parties responsible to carry out the tasks. The shaded cells in the following table reflect the major effort for each task/action.

Event / Documentation	Responsibility				
	CxP	Owner / A/E	GC/CM	MEP/TAB Contractor	BAS Contractor
Prepare Cx Plan	Create/ Update	Review	Review	Review	Review
Functional-Performance Tests (FPT)	Observe / Document	Observe	Schedule	Execute	Execute
Cx Issues Log	Write / Update	Review	Verify Completion	Correct	Correct
Preliminary Commissioning Report	Write	Review	Review	Review	Review
Seasonal Testing	Observe / Document	Observe	Schedule	Execute	Execute
Final Cx Report	Write	Review	No Action	No Action	No Action

1.09 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
   1. Include scope to complete commissioning requirements in the Contract price.
   2. Integrate and coordinate commissioning process activities with construction schedule. Include time in the project schedule for completion of Functional-Performance Tests. Include time for resolution of deficiencies found during Functional-Performance Tests.
   3. Review and accept commissioning process Functional-Performance Test procedures provided by the Commissioning Provider.
   4. Attend commissioning scheduling and coordination meetings as requested.
   5. Execute the Functional-Performance tests while the CxP witnesses and documents.
   6. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.

7. Cooperate with the CxP for resolution of issues recorded in the Issues Log.
8. Attend commissioning team meetings typically held each day the CxP is on-site (either prior to or immediately following the day's tests).
9. For Seasonal Testing, provide personnel at the project site to execute testing during peak heating and/or cooling season(s).
10. Complete Functional-Performance Test procedures.

1.10 BUILDING AUTOMATION SYSTEM (BAS) CONTRACTOR

A. The BAS Contractor shall execute most of the HVAC Functional-Performance testing. BAS contractor shall assign representatives with expertise and authority to act on their behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to Section 1.9 above and the following:
   1. Review the Functional-Performance Tests developed by the CxP to ensure that control system points are in place to execute the tests. Recommend test revisions to streamline or improve the test procedures.
   2. Calibrate all sensors prior to commencing functional performance testing. Provide calibrated handheld test equipment (for airflow, temperature, humidity, amperage, pressure, etc.) as dictated within the Functional-Performance Tests for use during on-site testing
   3. Provide controls system technician intimately familiar with the system for use during witnessing of the Functional-Performance Tests
   4. Demonstrate BAS system performance to Commissioning Provider during witnessing of the Functional-Performance Tests including all modes of system operation, alarm reporting, execution of commands, etc.

1.11 TEST, ADJUST, AND BALANCING (TAB) CONTRACTOR

A. TAB contractor shall assign representatives with expertise and authority to act on their behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
   1. Provide TAB technician intimately familiar with the project for use during verification of TAB.
   2. Submit Engineer-approved TAB report to CxP in advance of TAB verification by CxP. If an approved report is not available, provide preliminary report.
   3. Take measurements requested by the CxP during TAB verification with the same instruments used during original TAB Work. CxP will expect to observe the same measurements as those indicated in TAB Report (+/- testing equipment accuracies).
   4. Provide calibrated handheld test equipment (for airflow, temperature, humidity, amperage, pressure, etc.) as dictated within the Functional-Performance Tests for use during on-site testing.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 FUNCTIONAL-PERFORMANCE TESTING

A. CxP will create an FPT for each type of equipment within the Cx scope of work.

B. The Division 1 Contractor shall determine which subcontractor(s) is/are responsible for the Functional-Performance Test execution for each specific piece of equipment.

C. The Division 1 Contractor shall have the responsible subcontractor review and approve Functional-Performance Tests prepared by CxP to ensure they are applicable to the project, can be performed, and will not damage equipment.

D. The CxP will schedule through the Division 1 Contractor the Functional-Performance Test witnessing of selected pieces of equipment / systems.

E. The following is a summary of the systems that are intended to be Functional-Performance Tested as part of this project:

HVAC Systems (Division 23)

System or Equipment	Equipment or Component Tested	General Description of Modes and Functions to Test	Test Strategy	Seasonal Test
Heating System	Boiler, steam converters, pumps, controls.	All sequences of hot water systems and related pumps (startup, shutdown, load changes, resets, lead lag, alarms, lockouts), emergency power, capacities.	Test all.	Winter or summer if at least 50% loading is possible.
Air Handling System, Exhaust Air Handling Units	AHU, supply, return, exhaust fans, coils, coil pumps, valves, dampers, VFDs, controls, reheat coils.	All sequences of fans and related components (startup, shutdown, unoccupied mode, load changes, resets, alarms, lockouts), VFD control, operation of all dampers in all modes, emergency power, coil capacity, outside air control.	Test all air handling units.	Anytime
Terminal Units	VAV or CV boxes, fan-coil unit, thru-wall unit, unit heaters.	Verify damper and fan sequences during heating, cooling, occupied, unoccupied modes. Check dead-bands, verify flow.	Test 25%	Anytime.
Fans	Supply, central exhaust, stairwell pressurization, garage, etc.	All sequences, occupied, unoccupied, local control, overrides, schedules, control sequences. Testing of stairwell pressurization fans is for functionality and not for AHJ acceptance	Test all.	Anytime.
Building Automation System	Schedules, sequences, lockouts, alarms, interlocks, control strategies, trending, graphics	All sequences of controls for mechanical equipment and lighting controls.	Test all controlled equipment.	Anytime.
Test & Balance	Air and Water	Verify air handling unit water coil balancing and air flow measuring stations. Sample tenant water coil balancing	All air handling units, test min. 25% terminal units	Anytime.

3.02 INTEGRATED SYSTEM TESTING

A. CxP will provide the Division 1 Contractor a list of systems included in Integrated System Testing (IST).

B. The Division 1 Contractor shall determine all affected subcontractor(s) and ensure appropriate personnel is available to perform the Integrated Systems Test for the designated system(s).

C. The Division 1 Contractor shall have the responsible subcontractor review and approve Integrated System Tests prepared by CxP to ensure they are applicable to the project, can be performed and will not damage equipment.

D. The Integrated System Test for each system shall not be executed until the Functional-Performance Tests for all associated equipment have been successfully completed and documented by the CxP

E. Assist the CxP in scheduling the Integrated System Tests.

3.03 NON-CONFORMANCE AND RETESTING

A. Non-Conformance.

1. The CxP will record the results of the testing. All deficiencies, non-conformance issues, or test failures shall be noted and reported to the Contractors in the Issues Log, maintained by the CxP in a punch-list format.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxP. In such cases the deficiency and resolution will be documented on the procedure form.
3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures; however, the CxP will not be pressured into overlooking deficient Work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owner's Representative.

B. Re-testing.
1. The Contractor shall retest the equipment until all deficiencies have been resolved and provide signatures where applicable on the Functional-Performance Test form indicating that the deficiency has been corrected. The CxP will witness retesting at their discretion based on the criticality of the deficiency and time available on site.
2. The time/cost for the CxP to perform any re-testing will be back-charged to the Division 1 Contractor if either (a) an item was overlooked in the prerequisite documentation or (b) completion of an item was misrepresented in the prerequisite documentation. The Division 1 Contractor may then choose to recover costs from the party responsible for the item.
3. Re-testing by any contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Division 1 Contractor. The contractors will be provided with the commissioning test forms in advance to perform the tests as part of their checkout procedures.

3.04 DEFERRED TESTING

A. Unforeseen Deferred Tests. If any Test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of Testing may be delayed upon approval of the Owner. These tests shall be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties due to unforeseen deferred testing will be negotiated.

END OF SECTION

SECTION 230900

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Related Sections include the following:
   1. Division 23 Section "Control Sequences" for HVAC Sequences of Operation.
   2. Division 23 Section “Commissioning of HVAC” for requirements that relate to this section.
   3. Division 26 Section “Variable Frequency Motor Controllers” for requirements that relate to this section.
   4. Division 26 Section “Digital, Addressable Fire Alarm System” for requirements that relate to this section.
   5. Division 1 Section “General Commissioning Requirements” for requirements that relate to this section.

1.03 DESCRIPTION OF SYSTEM

A. Furnish and install a complete new Building Automation System, BAS, utilizing Direct Digital Controls, DDC, in accordance with drawings, specifications and intent of the design.

B. The new DDC BAS components shall be tied into the existing BAS network. The expanded BAS system shall be compatible and by the same manufacturer of the existing system and shall be complete in all respects. All DDC parameters shall be available through the BAS network and existing operator workstation. Providing the operator workstation is [**not**] a specification requirement. System access is provided by the operator workstation, network terminal and remote access via modem by manufacturer.
   1. The design intent is to provide upgrades to and utilize the existing software interface at the BAS existing operator workstation. The operator interface description as indicated in the specifications indicates the capabilities of the work station. Software upgrades to utilize workstation capabilities including graphical interface is a requirement of these specifications as required to perform HVAC equipment sequences specified

C. The BAS shall comply with the latest ANSI/ASHRAE Standard 135, BACnet. This system is to control all mechanical equipment, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc. and all air handlers, boilers, chillers, and any other listed equipment using native BACnet-compliant components.

D. All components not specifically indicated or specified, but necessary to make the system function within the intent of the specification, are to be included.

E. Size all control apparatus to properly supply and/or operate and control the apparatus served.

F. All electrical products shall be listed and labeled by UL and comply with NEMA Standards.

G. All electrical work required as an integral part of the Building Automation System is the responsibility of the control contractor, including but not limited to control wiring, interlock wiring, electrical wiring, smoke dampers, and associated control power wiring including power to control panels. This is in addition to power indicated to control panels for air handling units and other

pieces of mechanical equipment. All control wiring and conduit shall comply with NEC and Division 26 Specifications.

H. All wiring shall be installed in conduit/MC Cable when located within walls and/or inaccessible ceiling spaces. Wiring/cabling can be run exposed on j-hooks above accessible ceiling areas. Provide plenum rated cabling as required.

I. All computing devices, as defined in FCC Rules and Regulations, Part 15, shall be verified to comply with the requirements for Class A computing devices and labeled as set forth in FCC Rules and Regulations, Part 15.

J. Field Enclosures: Enclosures shall conform to the requirements of NEMA. Finish color shall be of the manufacturer's standard, unless otherwise stated. Damaged surfaces shall be repaired and/or refinished to its original condition.

K. Provide remote communication to the BAS system.

L. Any control devices subject to corrosion, such as in fume hood exhaust duct or in pool or in seacoast atmosphere, shall be provided with appropriate corrosion protection.

1.04 DEFINITIONS

A. BAS: Building Automation System

B. DDC: Direct digital control.

C. I/O: Input/output.

D. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

E. MS/TP: Master slave/token passing.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.05 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:
   1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
   2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
   3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
   4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
   5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
   6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
   7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
   8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows unless noted otherwise:
      a. Water Temperature: Plus or minus 1 deg F.
      b. Water Flow: Plus or minus 5 percent of full scale.
      c. Water Pressure: Plus or minus 2 percent of full scale.
      d. Space Temperature: Plus or minus 1 deg F.
      e. Ducted Air Temperature: Plus or minus 1 deg F.

f. Outside Air Temperature: Plus or minus 2 deg F.
g. Dew Point Temperature: Plus or minus 3 deg F.
h. Temperature Differential: Plus or minus 0.25 deg F.
i. Relative Humidity: Plus or minus 5 percent.
j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
l. Airflow (Terminal): Plus or minus 10 percent of full scale.
m. Air Pressure (Space): Plus or minus 0.01-inch wg.
n. Air Pressure (Ducts): Plus or minus 0.01-inch wg.
o. Carbon Monoxide: Plus or minus 5 percent of reading.
p. Carbon Dioxide: Plus or minus 50 ppm.
q. Electrical: Plus or minus 5 percent of reading.

1.06 SEQUENCE OF OPERATION

A. Refer to Division 23 Sections for Control Sequences.

1.07 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. DDC System Hardware: Bill of materials of equipment indicating manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
   3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.
   4. Details of control panel faces, including controls, instruments, and labeling.
   5. Schedule of dampers including size, leakage, and flow characteristics.
   6. Schedule of valves including flow characteristics.
   7. DDC System Hardware:
      a. Wiring diagrams for control units with termination numbers.
      b. Schematic diagrams and floor plans for field sensors and control hardware.
      c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   8. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
   9. Controlled Systems:
      a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
      b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
      c. Written description of sequence of operation including schematic diagram.
      d. Points list.

1.08 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: If the proposed DDC system is based on Bacnet protocol, certify that each proposed DDC system component complies with ASHRAE 135. If the proposed DDC system is based on LonWorks protocol, certify that each proposed DDC system component complies with LonWorks.

B. Qualification Data: For Installer and manufacturer.

C. Field quality-control test reports.

D. Submittal Schedule
   1. The Controls Contractor shall submit a working version of the project control software 45 days after approval of submittals. The Controls Contractor shall provide the software on the project's BAS use interface PC or laptop. The Engineer or Commissioning Authority shall preview the progress and intent of the logic and graphics.
   2. The Owner may make this submission requirement a prerequisite for 25% payment.

1.09 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
   1. Interconnection wiring diagrams with identified and numbered system components and devices.
   2. Keyboard illustrations and step-by-step procedures indexed for each operator function.
   3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   4. Calibration records and list of set points.
   5. The Building Automation System contractor shall furnish to the Engineer, upon completion of the work, but before final acceptance of the system, a pdf copy of instructions covering complete maintenance and operation of the system and a complete set of as-built drawings of control diagrams.
   6. Maintenance instructions shall include manufacturer's literature on all system equipment components. All maintenance instructions shall be explicit concerning time intervals for all servicing and preventative maintenance, types and grades of oil and/or grease, packing materials, normal and abnormal clearance, methods of equipment adjustments, and a complete description of replacement parts and materials for wearing items.
   7. Upon completion of the installation, the control contractor shall submit to the Owner a proposal to provide the necessary programmed maintenance to keep the system in proper working condition. This proposal shall fully describe the maintenance cost of this work during the guarantee period as well as for subsequent years thereafter.
   8. List of spare parts for each type of control device.
   9. Contact names and 24 hour telephone numbers for service..
   10. A list and documentation of all custom software created.
   11. ACAD files for the drawings, BAS software files, database files and files of all color graphic screens created for the project.
   12. Guarantees and warranty documents for all equipment and systems.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On disc, complete with data files and graphic screens.
   3. Device address list.
   4. Software license for DDC workstations and control systems.

C. Training Manuals: The contractor shall provide a course outline and training manuals for all training classes for Engineer's and Commissioning Authority if one exists review. The Engineer or Commissioning Authority may modify training materials to meet the needs of the Owner.

Review and approval by the Engineer shall be completed prior to substantial completion and the first training class

1.10 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.11 QUALITY ASSURANCE

A. Installer Qualifications: The control system shall be installed by competent control technicians under the direct employment of local branch office of the manufacturer of the control equipment. All control equipment shall be the product of one manufacturer. The control contractor shall have local maintenance capabilities available within a 100 mile radius of the project site. The control contractor must have installed Direct Digital Controls of the type and manufacturer specified for at least five years prior to commencing this project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.12 GUARANTEE/MAINTENANCE

A. Guarantee the BAS to maintain the temperature in rooms within one degree of the setting and further guarantee all work, materials equipment, and controls against defects in workmanship and material and provide service for a period of one (1) year from date of final acceptance.

B. Replace any defective workmanship or material developing within that time as soon as possible at no charge to the Owner.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. Field-Installed Components: Shall be protected per Division 23 Section “Common Work Results for HVAC”

1.14 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.

C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

E. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

F. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

G. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.

H. Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.

PART 2 - PRODUCTS

2.01 CONTROL SYSTEM

A. Manufacturers:
   1. Trane

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.02 DDC EQUIPMENT

A. Application Software:
   a. I/O capability from operator station.
   b. System security for each operator via software password and access levels.
   c. Automatic system diagnostics; monitor system and report failures.
   d. Database creation and support.
   e. Automatic and manual database save and restore.
   f. Dynamic color graphic displays with up to 10 screen displays at once.
   g. Custom graphics generation and graphics library of HVAC equipment and symbols.
   h. Alarm processing, messages, and reactions.
   i. Trend logs retrievable in spreadsheets and database programs.
   j. Alarm and event processing.
   k. Object and property status and control.
   l. Automatic restart of field equipment on restoration of power.
   m. Data collection, reports, and logs. Include standard reports for the following:
      1) Current values of all objects.
      2) Current alarm summary.
      3) Disabled objects.
      4) Alarm lockout objects.
      5) Logs.
   n. Custom report development.
   o. Utility and weather reports.
   p. ASHRAE Guideline 3 report for chillers.
   q. Workstation application editors for controllers and schedules.
   r. Maintenance management.

B. Custom Application Software:
   a. English language oriented.
   b. Full-screen character editor/programming environment.
   c. Allow development of independently executing program modules with debugging/simulation capability.
   d. Support conditional statements.
   e. Support floating-point arithmetic with mathematic functions.
   f. Contains predefined time variables.

C. Control Units: Modular, comprising of processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
   1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
   2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
      a. Global communications.
      b. Discrete/digital, analog, and pulse I/O.
      c. Monitoring, controlling, or addressing data points.
      d. Software applications, scheduling, and alarm processing.
      e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
   3. Standard Application Programs:
      a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
      b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
      c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
      d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
      e. Remote communications.
      f. Maintenance management.
      g. Units of Measure: Inch-pound and SI (metric).
   4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

D. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
   1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
   2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
      a. Global communications.
      b. Discrete/digital, analog, and pulse I/O.
      c. Monitoring, controlling, or addressing data points.
   3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
   1. Binary Inputs: Allow monitoring of on-off signals without external power.
   2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
   3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
   4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
   5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.

6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
7. Universal I/Os: Provide software selectable binary or analog outputs.

F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
2. Maximum response time of 10 nanoseconds.
3. Minimum transverse-mode noise attenuation of 65 dB.
4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.03 UNINTERRUPTIBLE POWER SUPPLY SYSTEM

A. Provide wall mounted UPS sized for specific application plus 20% spare capacity. Panel shall be equipped with receptacle for UPS connection to utility power. Panel to be mounted adjacent to BAS panel served. Provide one UPS for each systems level control panel.

2.04 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms.
3. Enclosure: In conditioned spaced, dustproof rated for operation at 32 to 120 deg F. In outdoor applications or in wet ambient conditions, waterproof rated for operation at minus 10 to 150 deg F.

2.05 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F, and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

2.06 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. RTDs and Transmitters:
1. Accuracy: Plus or minus 0.2 percent at calibration point.

2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements in Ducts: Single point; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
4. Averaging Elements in Ducts and Air Handling Units: 24 feet long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required. Provide averaging sensors for all mixed air applications.
5. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
6. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Concealed for public areas.
   b. Set-Point Indication: Concealed.
7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. Humidity Sensors: Bulk polymer sensor element.
   1. Accuracy: 2 percent full range with linear output.
   2. Room Sensor Range: 20 to 80 percent relative humidity.
   3. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   4. Duct Sensor: 0 to 100 percent relative humidity range with element guard and mounting plate.
   5. Outside-Air Sensor: 0 to 100 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.

D. Pressure Transmitters/Transducers:
   1. Manufacturers:
      a. BEC Controls Corporation.
      b. General Eastern Instruments.
      c. MAMAC Systems, Inc.
      d. ROTRONIC Instrument Corp.
      e. TCS/Basys Controls.
      f. Vaisala.
      g. Veris
   2. Static-Pressure Transmitter: Bidirectional sensor with suitable range for expected input, and temperature compensated. The minimum range shall be -.01” to 0.01” w.g. The transmitter shall have four switch selectable ranges. Transmitter shall operate from 24VDC or 24VAC. Transmitter shall have an integral LCD display. Make: Veris or equal.
      a. Accuracy: 1 percent of full scale at any range with repeatability of 0.5 percent.
      b. Output: linear field selectable of 0-10V or 4 to 20 mA.
      c. Proof Pressure: 3 psid
      d. Building Static-Pressure Range: 0- to 0.25-inch wg.
      e. Duct Static-Pressure Range: 0- to 5-inch wg.
   3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service. The transmitter shall have four switch selectable ranges. Transmitter shall operate from 24VDC or 24VAC. Transmitter shall be provided with the pressure sensors. Transmitter shall have an integral LCD display. Make Veris or equal.
      a. Accuracy: 1 percent of full scale at any range with repeatability of 0.5 percent.
      b. Output: linear field selectable of 0-10V or 4 to 20 mA.
      c. Operating Pressure: minimum 150-psig
      d. Proof Pressure: 2 times full scale range.
      e. Burst Pressure: 5 times full scale range
   4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service. The transmitter shall have four switch selectable ranges. Transmitter shall operate from 24VDC or 24VAC. Transmitter shall be provided with the pressure sensors. Transmitter shall have an integral LCD display. Make Veris or equal.
      a. Accuracy: 1 percent of full scale at any range with repeatability of 0.5 percent.
      b. Output: linear field selectable of 0-10V or 4 to 20 mA.

c. Operating Pressure: minimum 150-psig
d. Proof Pressure: 2 times full scale range.
e. Burst Pressure: 5 times full scale range

5. Differential-Pressure Switch (Air or Water): Adjustable, snap acting, with pilot-duty rating and with suitable scale range and differential. Provide switch with auxiliary contacts for remote notification of BAS.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

E. Room sensor accessories include the following:
1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.

2.07 STATUS SENSORS

A. Status Inputs for Fans, Pumps, and Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current. The smart current sensor shall be compatible with the 4-20 MA signal for the DDC panel. The current sensor shall provide a resistance change proportional to the input signal.

B. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

C. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

2.08 GAS DETECTION EQUIPMENT

A. Available Manufacturers:
1. Ebtron, Inc.
2. Honeywell International Inc.; Home & Building Control.
3. Sauter Controls Corporation.
4. TSI Incorporated.
5. Vaisala.
6. Vulcain Inc.

B. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; 5 year recommended calibration interval; LCD Display; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for duct or wall mounting as indicated on drawings.

2.09 OCCUPANCY SENSOR: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.10 AIRFLOW MEASURING STATIONS

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station or Ebtron.
1. Manufacturers:
a. Air Monitor Corporation.
b. Ebtron
c. Wetmaster Co., Ltd.
2. Casing: Galvanized-steel frame.
3. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches deep.
4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

5. Performance:
    a. Monitor accuracy within 5%.
    b. Airflow range for operation between 150fpm and 2000fpm.

B. Combination Outside Air Damper/Air Flow Station
1. Furnish and install at locations shown on the plans, or as in accordance with schedules, an air monitor station integral to the minimum outside air damper. The integral air monitor/damper shall incorporate measuring ports built into the damper blades and shall controls the minimum amount of outside air as recommended by ASHRAE Standard 62. The construction of the air monitor/damper shall be 6' x 1.375" x .125" (152 x 35 x 3.18) aluminum frame. The IAQ50 frame shall be designed for 4 bolt and flange cleat installation an shall provide maximum free area for lowest pressure drop performance. The damper blades shall be heavy gage aluminum airfoil type with Ruskiprene blade edge seals. Jamb seals shall be flexible metal compression type and the linkage shall be concealed out of the airstream and located within the damper frame to reduce pressure drop and noise. The integral damper/monitor assembly shall incorporate an air straightener section to ensure proper airflow readings. The air straightener section shall be flanged as required by the application. Each air monitor/damper shall include 24VAC electric modulating motor and an application specific controller designed for this application furnished by the damper manufacturer. Each integral air monitor/damper shall be calibrated in an AMCA registered laboratory and a certification chart shall accompany the air monitor/damper. The integral air monitor/damper shall be Ruskin's Model IAQ50.
2. Performance:
    a. Ultra-low leakage. (3 cfm per square ft at 1" w.g.)
    b. Monitor accuracy within 5%.
    c. Airflow range for operation between 150fpm and 2000fpm.

2.11 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based on every day of week.
7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:
    a. Time of day.
    b. Actual room temperature.
    c. Programmed temperature.
    d. Programmed time.
    e. Duration of timed override.
    f. Day of week.
    g. System mode indications include "heating," "off," "fan auto," and "fan on."

C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical

rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

E. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

F. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

G. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point. Provide switch with auxiliary contacts for remote notification of BAS.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

H. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point. Provide switch with auxiliary contacts for remote notification of BAS.

1. Bulb Length: Minimum 20 feet.
2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

2.12 HUMIDISTATS

A. Manufacturers:

1. MAMAC Systems, Inc.
2. ROTRONIC Instrument Corp.

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

2.13 ACTUATORS

A. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers:
   a. Belimo Aircontrols (USA), Inc.
   b. Bray,
   c. Delta,
   d. Honeywell,
   e. Johnson Controls
   f. Siemens
   g. Or equal standard products of the BAS manufacturer.
2. Each actuator shall be of sufficient capacity to operate the damper or valve under all conditions, and to guarantee tight close-off of dampers and valves against system temperature and pressure encountered.

3. Valves: Size for torque required for valve close off at maximum pump differential pressure.
4. Dampers: Size for minimum running torque calculated as follows:
    a. Parallel-Blade Damper: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper: 5 inch-lb/sq. ft. of damper.
    c. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by a factor of 1.5.
    d. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by a factor of 2.0.
5. Coupling: V-bolt and V-shaped, toothed cradle. Provide actuators with proper linkages, mounting clamps and brackets for mounting and attaching to device. Actuators employing linkages between the actuator and damper/valve stem may be utilized subject to meeting specified requirements including additional start up requirements of Part 3.
6. Overload Protection: Electronic overload or digital rotation-sensing circuitry to prevent actuator damage due to stall throughout entire rotation. End switches to deactivate the actuator at end of rotation or magnetic clutches are not acceptable.
7. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
8. Power Requirements (Two-Position Spring Return): 24-V ac. If site conditions require the use of 120 V actuators, coordinate power requirements with the Division 26 contractor.
9. Power Requirements (Modulating): Maximum 10 VA while running and 5 VA while holding at 24-V ac or 8 W at 24-V dc.
10. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
11. Temperature Rating: Minus 22 to plus 122 deg F at 95% non-condensing relative humidity, unless noted otherwise.
12. Each actuator shall be full-proportioning or two position as indicated or specified. Provide actuators with spring return for normally open or closed position for fire freeze, moisture protection or fail safe operation on power interruption as indicated, specified and/or as required.
13. Actuators shall be constructed of galvanized steel, aluminum or stainless steel as required by applications and as specified.
14. Provide a two (2) year unconditional warrantee of actuator and, when utilized, linkages from the date of substantial completion.
15. Provide actuators with position feedback for proof of actual position and auxiliary switches as indicated in points list or sequence of operation.
16. The use of paralleled actuators to increase torque is acceptable.
17. Provide manufacturer's weather shield for actuators exposed to the weather.
18. Provide actuators with visual position indication.
19. Spring return actuators shall not exceed noise levels of 62 dBA when running. Non spring return actuators shall not exceed noise levels of 45 dBA when running. Spring return actuators shall include an electronic cutoff when holding at driven position so that holding noise level shall be inaudible.

B. Electronic Damper or Valve Actuators
1. Valve actuators shall include a thermal barrier and air space between valve and actuator to prevent condensation in actuator for chilled water applications.
2. Provide industrial actuators for butterfly valves 4" and larger and for damper exceeding 600 in-lbs of torque. Actuators shall include the following features:
    a. Built-in thermostat and heater, pre-wired to a terminal block.
    b. NEMA-4 enclosure
    c. Provision for emergency manual over-ride
    d. Electric motor brake
    e. Accessible, adjustable end limit switches

f. Modulating actuators shall have a PC board that will allow for field changes to control input, control output, direction of rotation and calibration through pushbutton programming

3. Actuator shall be compatible with the controlled closure device requiring 7 to 15 seconds for damper closure to allow duct pressure equalizing.

2.14 CONTROL VALVES

A. Manufacturers:
1. Belimo
2. Bray
3. Honeywell
4. Johnson Controls
5. Siemens
6. Danfoss Inc.; Air Conditioning & Refrigeration Div.
7. Hayward Industrial Products, Inc.
8. Magnatrol Valve Corporation.
9. or equal standard products of the BAS manufacturer

B. The BAS Contractor shall furnish all control valves as shown on the plans and/or as required to perform the control sequence specified. Equipment may be furnished with integral control valves in accordance with specifications.

C. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

D. Hydronic system valves shall have the following characteristics:
1. Sizing: 5-psig maximum pressure drop at design flow rate or the following:
a. Two Position: Line size.
b. Two-Way Modulating: Either the value specified above or the load pressure drop, whichever is more.
c. Three-Way Modulating: The load pressure drop, but not more than value specified above.
2. Flow Characteristics: Modulating 2-way valves shall have equal percentage flow characteristics; Modulating 3-way valves shall have linear flow characteristics maintaining a constant total flow at all valve positions.
3. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head

E. Hydronic system globe valves shall have the following characteristics:
1. NPS 2 and Smaller: Class 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

F. Characterized Ball Control Valves
1. At the Contractor's option, characterized ball type control valves can be used for hydronic systems where sizing permits.
2. Valves ½" through 2" shall be forged brass body with nickel plating, NPT screw type. The operating range shall be 0^0 to 212^0 F at 300 psi minimum. Characterized ball type control valves shall be furnished with a stainless steel ball and stem and fiberglass reinforced Teflon or EPDM seats and seals.

3. The valves shall have an ISO type 4-bolt flange for mounting actuator in any orientation parallel or perpendicular to the pipe. A non-metallic thermal isolation adaptor shall separate the flange from the actuator.
4. The isolation adaptor shall also provide stable direct coupled mechanical connection between the valve body and actuator and prevent lateral or rotational forces from affecting the stem and its packing O-rings.

G. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
1. Body Style: Lug.
2. Disc Type: Aluminum bronze.
3. Sizing: 1-psig maximum pressure drop at design flow rate.

2.15 DAMPERS

A. General
1. Provide 304 stainless steel construction when installed in stainless steel duct systems or when shown on the plans.

B. Control Dampers
1. Available Manufacturers:
   a. Air Balance Inc.
   b. Greenheck
   c. Pottorff; a division of PCI Industries, Inc
   d. Ruskin
   e. or equal standard products of the BAS manufacturer
2. The Control Contractor shall furnish all control dampers as shown on the plans and/or as required to perform the control sequence specified except those furnished with fan equipment. All modulating dampers shall be sized by the Control Contractor to meet flow requirements of the application in accordance with his recommendation. All two position dampers to be sized as close as possible to duct size, but in no case is damper size to be less than 90% of duct area.
3. Dampers: AMCA-rated, 0.108-inch-minimum thick, galvanized-steel or 0.125-inch-minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.078-inch-thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.
   a. Blade design:
      1) Mixing applications (modulating or two position): Use parallel blade dampers configured to direct the mixing airstreams into each other.
      2) Modulating applications: Use opposed blade dampers.
      3) Two position applications: Use either opposed or parallel blade dampers.
4. Operating Temperature Range: From minus 40 to plus 200 deg F.
5. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
6. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D. Dampers shall be Ruskin CD60, D-1300 or equal.

2.16 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.01 GENERAL

A. Install all control equipment and wiring in a neat and workmanlike manner to the satisfaction of the Architect and/or Engineer.

B. All immersion wells, pressure tappings and any associated shutoff cocks, flow switches, level switches and other such items furnished by the control manufacturer shall be installed by the mechanical contractor under the coordinating control and supervision of the control contractor.

C. Install all control devices in a location accessible to maintenance personnel. For example: above a lay-in ceiling and not a hard ceiling, actuators facing downward or sideways in congested areas, valves near floor level instead of at high points, etc.

D. Provide, install, calibrate and demonstrate to the owner a complete and functioning control system per the specified sequence of operations and commissioning requirements.

E. All wiring required for a full and functioning control system per the sequence of operations is work of this section.

F. All control panels shall be provided and installed where shown on plans or detailed within the specifications. Control panels provided to locations other than shown shall be provided, installed and powered by the control system manufacturer/installer. The controls contractor is to provide ample power wiring to power all panels from Power Panels as designated.
   1. Control panels for the rooftop air handlers shall be located at a location approved by the Architect/Engineer.
   2. Control panels for the indoor air handlers shall be located within the same room as the air handler.

G. Provide and install all devices, and wiring between HVAC manufacturer's factory installed equipment and all remotely mounted equipment such as flow switches and, data gathering cabinets and miscellaneous equipment for a complete and operating system.

H. All terminations made within the control manufacturer/ installers panels shall be verified and tested prior to final powering of panel. Control devices from other systems shall not be temporarily or permanently mounted within the control panel.

I. Electrical Wiring:
   1. All electrical wiring for the control system, including power circuit to control panels, both line and low voltage unless otherwise indicated, shall be furnished and installed by the control contractor in metal conduit and in accordance with all the electrical sections of this specification and all applicable electrical codes. This is in addition to power indicated on Division 26 drawings for control panels for air handling units and other pieces of mechanical equipment.
   2. Control panels serving equipment fed by emergency power shall be fed by emergency power.

J. Electrical Work:
   1. Control Wiring: Control wiring shall be provided as a part of this specification section. Run all control wiring separate from power wiring, also do not utilize the same conduit for analog sensor wiring and any wiring carrying an AC current. Install wiring in accordance with the National Electric Code, and applicable local codes. All wire and wiring devices used shall be certified by the temperature controls subcontractor.
   2. Power Wiring: Power wiring to all DDC panels, VAV box controllers, and additional control devices as required, shall be provided as part of this work. Power circuits to DDC panels shall not be shared with any other electrical equipment. Power wiring required by the control manufacturer/installer for electric end devices (eg: actuators, relays, etc.) is work of this section. All conduit, wire, hangers, etc. associated with wiring to end devices is work of this section.

3. All EMT shall be a minimum of 3/4" in diameter. Steel compression fitting shall be used to join EMT with electrical boxes, cabinets and panels.

K. Test And Balance And Commissioning:
   1. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance and commissioning purposes.
   2. The Contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
   3. In addition, the Contractor shall provide a qualified technician to assist in the test and balance and commissioning process.
   4. The tools used during the test and balance and commissioning process will be returned at the completion of the testing and balancing and commissioning.

L. Work By Others:
   1. All valves and dampers shall be installed by the mechanical contractor. All pipe and duct penetrations shall be provided by the mechanical contractor, or his designated subcontractor.

M. Dampers:
   1. All dampers furnished by the control manufacturer shall be installed by the mechanical contractor under the coordinating control and supervision of the control contractor.
   2. Any necessary blank-off plates or transitions required to facilitate the standard size dampers shall be provided by the mechanical contractor. In areas where the damper is 70% or more of the duct area, blank-off plates are to be used. In areas where the damper is less than 70% of the duct area, a transition shall be provided.

N. Valves:
   1. All temperature control valves, furnished by the control manufacturers shall be installed by the mechanical contractor under the coordinating control and supervision of the control contractor.
   2. Valve submittals shall be coordinated for type, quantity, size and piping configuration to ensure compatibility with pipe design.
   3. Slip-stem control valves shall be installed so that the stem position is not more than 60 degrees from the vertical up position. Ball type control valves shall be installed with the stem in the horizontal position.
   4. Valves shall be installed in accordance with the manufacturer's recommendations. Installation in a horizontal pipe run is preferred.
   5. Control valves shall be installed so that they are accessible and serviceable and so that actuators may be serviced and removed without interference from structure or other pipes and/or equipment.
   6. Unions shall be installed at all connections to screw-type control valves.
   7. Provide tags for all control valves indicating service and number. Match identification numbers as shown on approved controls shop drawings.

O. Freezestats:
   1. Install freezestats in all air handling units where indicated on the drawings or as specified. Unless otherwise indicated, install sensing element at the downstream side of heating coils.
   2. Distribute sensing element across the entire area of the medium being sensed. Install stats at accessible locations with suitable mounting brackets and element duct collars where required.

P. Specialized Space Monitor:
   1. Install room DP monitors adjacent to door outside of the control space being monitored. Control spaces with ante rooms to include either single monitor to monitor either spaces or two monitors. Mount DP monitor, accessories and sensors per manufacturer's instructions with pressure pickups above the door or in ceiling away from influence of supply air jets.
   2. Install multivariable monitors adjacent to other room sensors or as indicated.

3. Provide factory-authorized representative to perform start up, initial field calibration of the controller and Owner training.
4. Coordinate start up and set points with Test and Balance and the building control system.

Q. Connect flowmeter-system elements to meters.

R. Connect flowmeter transmitters to meters.

S. Connect thermal-energy-meter transmitters to meters.

T. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions

3.02 EXAMINATION

A. Verify that power supply is available to control units and operator workstation.

3.03 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Controllers:
1. Install local application specific controllers where indicated on the plans or suitable location adjacent to the system served. Mount panel on wall with suitable brackets. Co-ordinate controller locations with other trades.

D. Space Sensors:
1. Verify location of thermostats, humidistats, and other exposed control sensors with drawings, room details and Architect before installation. Install devices 48 inches above the floor to the top of the device.
   a. Any room thermostats/temperature sensors mounted on exterior walls shall be mounted on thermally insulated sub-base.
   b. Relocate room thermostats/temperature sensors if required due to draft, interferences with cabinets, artwork, furniture, etc., or improper sensing.
2. Install guards on thermostats in the following locations:
   a. Entrances.
   b. Public areas.
   c. Where indicated.

E. Duct/Piping Sensors:
1. Install duct pressure, temperature or humidity sensors where indicated or directed to meet job site conditions.
2. Mount all sensors per manufacturer’s requirements.
3. Relocate duct sensors if required due to improper sensing.
4. Mount averaging sensors with serpentine sensing element across the entire area of the medium being sensed. Install sensors at accessible locations with suitable mounting brackets and element duct collars where required.
5. Install piping sensors on top of piping. Insulate duct and pipe sensors to prevent condensation of cold surfaces.
6. Provide matched temperature sensors for chilled and hot water differential temperature measurement. Differential accuracy shall be within 0.2° F.
7. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
8. For immersion sensors with wells, install thermal grease in well to improve conductivity.

F. Install automatic dampers according to "Air Duct Accessories."

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

I. Install labels on temperature and humidity sensors indicating the controlled device or equipment. Coordinate label style and location (e.g. Kroy/P-Touch tape, color coded dots, etc.) with architect and owner. Locate label on back of sensor cover where possible.

J. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

K. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."

L. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

M. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

N. Install flowmeter elements in accessible positions in piping systems with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

O. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

P. Install flowmeters at discharge of hydronic system pumps and where indicated on the drawings.

Q. Assemble components and install thermal-energy meters.

R. Mount meters on wall if accessible; if not, provide brackets to support meters.

3.04 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
   2. Install exposed cable in raceway.
   3. Install concealed cable in raceway.
   4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
   7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

C. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

D. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.05 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
   4. Test each point through its full operating range to verify that safety and operating control set points are as required.
   5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   6. Test each system for compliance with sequence of operation.
   7. Test software and hardware interlocks.

B. DDC Verification:
   1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
   2. Check instruments for proper location and accessibility.
   3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
   4. Check instrument tubing for proper fittings, slope, material, and support.
   5. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
   6. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
   7. Check temperature instruments and material and length of sensing elements.
   8. Check control valves. Verify that they are in correct direction.
   9. Check DDC system as follows:
      a. Verify that DDC controller power supply is from emergency power supply, if applicable.
      b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
      c. Verify that spare I/O capacity has been provided.
      d. Verify that DDC controllers are protected from power supply surges.

C. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.06 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate instruments.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
   4. Control System Inputs and Outputs:
      a. Check analog inputs at 0, 50, and 100 percent of span.
      b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
      c. Check digital inputs using jumper wire.
      d. Check digital outputs using ohmmeter to test for contact making or breaking.
      e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
   5. Flow:
      a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
      b. Manually operate flow switches to verify that they make or break contact.
      c. Calibrate meters according to manufacturer's written instructions, after installation.

6. Pressure:
    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.
8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**three**] <**Insert number**> visits to Project during other than normal occupancy hours for this purpose.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."
    1. Upon completion of the work and acceptance by the Owner, the installing Contractor shall provide installation/operation information to the Owner's operating personnel who have responsibility for the mechanical system. The contractor shall provide telephone support to the owner's operating staff for a period of one year for no additional cost.
    2. Contractor shall provide twenty (20) hours of training, in blocks of 4 hours, during normal business hours to a minimum of two (2) owner’s representatives designated by the facility. Training subjects and format shall be subject to the Owner’s approval. Training shall be digitally recorded by the Controls, to be handed over the facility for future use.

B. HARDWARE SUPPORT
    1. The manufacturer of the DDC system shall provide assistance in product applications and system trouble shooting. The materials and installation shall be guaranteed to be free of defects for one (1) year from date of beneficial use.

3.08 SYSTEM ACCEPTANCE

A. Upon completion of the project, the Building Automation System contractor shall:
    1. Completely adjust or calibrate all devices provided under this section.
    2. Provide testing and adjustment of the complete system as required per code or specification. Validate system points from the Personal Computer Operator Workstations to the field points.
    3. Test connected devices so that the displayed controlled variable is within plus or minus 2% of the actual sampled variable.
    4. Test remote access capabilities of the system including verifying remote alarm functionality.
    5. Participate and support commissioning efforts

B. The installing Contractor shall issue a report upon project completion stating that the system has been completed and adjusted has had all hardware and software functions verified, and is operating in accordance with the specifications. Any deviations from specified settings or

operations necessitated during system adjustment shall be specifically noted. A demonstration of complete system operation shall be made to the Owner's representative.

END OF SECTION

SECTION 230993

CONTROL SEQUENCES – GENERAL AND AIRSIDE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 01 specifications, apply to this section.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to Section 230900 – Instrumentation and Control for HVAC.

PART 3 - EXECUTION

3.01 GENERAL

A. This section is a supplement to the control diagrams on the drawings. The control diagrams generally indicate control devices as well as some desired logic. This section provides the basis for the sequences of operations, the control logic, device location clarification, measurements, as well as the general intent of the outcome for the control systems.

B. The Execution section Paragraphs are arranged in an alternate way to improve the clarity of the intent by avoiding duplication and repetition of the requirements common to multiple systems.

C. The abbreviations AFD, ASD, and VFD are used interchangeably and all represent the same adjustable speed drive controller for a motor.

3.02 POST-OCCUPANCY CONTROLS OPTIMIZATION REQUIREMENTS

A. After owner occupancy, the heating and cooling loads will dramatically change from when the control systems were initially set up in an empty building due to the owner's use of the building. The owner's actual occupancy of the building will also be slightly different from his initial programming assumptions shown on the design drawings. Optimization/alteration of the control system initial set-up will be required to meet the owner's specific occupancy.

B. The controls contractor, together with the mechanical contractor and TAB contractor are responsible for optimizing and dialing in the performance of the systems to meet the needs of the owner's occupancy conditions. The plans and specs require basic elements of adjustability (automatic and manual) to be provided in the vendor's proprietary controls systems. The controls contractor is the expert in his installed control systems and shall optimize and adjust many theoretical design setpoints to accommodate the as-built equipment and system conditions (which vary from the theoretical design assumptions) and the owner's actual occupancy.

C. After the owner has moved in, the controls contractor shall be responsible to optimize the operation, setpoints, and control logic for the as-built systems to alleviate owner comfort or operational complaints.

D. Prior to providing troubleshooting guidance, the engineer reserves the right to request documented validation of system set-up sign-off sheets, printouts of actual control software code, control data trends for suspected problem areas, re-TAB of suspected problem areas, and documentation of contractors self-troubleshooting efforts. It is the contractors burden to provide written documentation to the engineer to prove the systems are installed and set up according to the design intent.

3.03 GENERAL REQUIREMENTS FOR ALL SYSTEMS:

A. CONTROLLER POWER: The power for equipment control panels shall be powered from the line side of the starter for the equipment controlled or from a separate circuit (by Div. 23) so that the

controller will continue to have power and will stay on the BAS network when the unit is turned off or is off due to failure.

B. EMERGENCY POWER: If the equipment being controlled is on emergency power, then the controller must be on emergency power also.

C. CONTROL DEVICE POWER: The basis for control and monitoring of all actuators and control devices is to use low voltage 24V power. The controls contractor shall provide low voltage wiring for all controls. Since different controls contractors would execute the control wiring in different ways, the project documents do not include locations for source 120V power to feed the 24V power wiring – that task shall be the responsibility of the successful controls contractor. The controls contractor shall coordinate with the electrical contractor and compensate the electrical contractor for desired quantities and locations for 120V power sources to feed their low voltage system design.

D. 24V DAMPER AND VALVE ACTUATORS: The basis of design is for 24V low voltage actuators for all air-side dampers and water side valve actuators. The intent is for the controls contractor to have exclusive responsibility for installation and operation of all control systems – including the smoke and fire-smoke dampers.

E. SCHEDULES: The schedules shall be based upon a 24 hour, 365 day calendar with exception days and holidays.
   1. For multi building facilities provide four levels of scheduling. They shall be Area, Group, Building, and Unit. Units will be assigned into buildings, buildings into groups, and groups into areas. Each piece of equipment shall reference all of these schedules and if any of them are occupied, the equipment shall go into occupied mode.
   2. For single building facilities provide four levels of scheduling. They shall be Building, Floor, Wing, and Unit. Units shall be assigned to wings, wings into floors, and floors into buildings. Each piece of equipment shall reference all of these schedules and if any of them are occupied, the equipment shall go into occupied mode. If the building does not have multiple floors or wings, then those respective schedules may be eliminated.

F. ACTIVE SET POINTS: The control sequences shall reference active cooling and heating analog values. These values shall be set to the occupied set points during occupied mode and the unoccupied set points in unoccupied mode.

G. PRE/POST OCCUPANCY MODES: Each piece of equipment and system shall have pre and post occupancy variables to indicate how many hours before and after occupancy the equipment shall operate in pre/post occupancy mode. In pre/post occupancy mode, the equipment shall use occupied set points but shall use either no outside air or alternate ventilation rates.

H. ACTUATOR FEEDBACK: Provide BAS monitoring of position feedback of valve and damper actuators. The purpose for this requirement is for user identification of malfunctioning actuators at the BAS front end graphic screens, and to assist in commissioning, and to reduce the troubleshooting time schedule. End switches are not an acceptable method of monitoring partial positions. An actuator feedback alarm shall be generated if the position feedback differs from the commanded position by more than 15% for 5 minutes. Graphic points shall include the following for each actuator:
   a. Commanded Position.
   b. Position Feedback.
   c. Feedback Alarm

I. PID LOOP TUNING: It is expected that the controls technicians shall provide PID loop tuning for the various controlled systems to avoid overshooting and oscillation. At the minimum Proportional gain and the Integral time values shall be adjusted based upon device manufacturers recommendations, and the control technicians shall be able to discuss their P and I values with the engineer and commissioning authority. Common P&I values can be used for similar groups of devices (such as all supply VFD's or all 2-way HW control valves, etc).

Derivative time shall be 0 or off for most HVAC control loops. Only high reaction speed control loops, such as in laboratories and clean rooms, shall include D values. Small reheat valves are particularly subject to hunting, so loop tuning shall be included for those devices.

J. VARIABLE FREQUENCY/ADJUSTABLE SPEED DRIVE CONTROL AND MONITORING: The basic specification for VFD equipment requires a CAT 5 connection to the control system. The controls contractor shall incorporate the VFD's manufacturer's data format to at least display the internal set-up values (generally in the range of 50-100 data points) and operating values if the operator chooses to observe the operation of a VFD on a separate graphics/data screen. The basic VFD operating data described in subsequent sections shall be provided on the related equipment graphics screen. Providing the operator the ability to quickly evaluate and troubleshoot a VFD and related motor from the BAS front-end is a high value feature since improperly operating VFD's can waste large amounts of unnecessary energy, and of course comfort complaints.

K. ALARM PRIORITY: The BAS shall provide alarms in a logical manner to assist the facility operator in prioritizing alarms. Alarm tags shall include the point name, general equipment name, priority level, and alarm description. For example: KRMC:P07:AHU07_CCTEMP, AHU-7 Cooling Coil Temperature Sensor, Medium Priority, High leaving air temperature 5F above set point. Prioritize alarms based upon the following criteria. Submit alarm priority to engineer for review.
High Priority – equipment failure, freezing, over heating, etc.
Low Priority – high/low temperatures, pressures, dirty filters, diagnostics, etc.

L. Provide function to delete all alarms from the print queue manually if desired. Provide function to sort alarms by priority and print alarms by priority. Provide a graphic page to view both priority alarms. Provide a local error message link in the lower corner of the graphic display of the AHU to display just error messages associated with the pieces of equipment displayed in the graphic page.
High Priority Alarm List. Provide a link to display the last 10 high priority alarm messages associated with the piece of equipment.
Low Priority Alarm List. Provide a link to display the last 10 low priority error messages.

M. CURRENT TRANSDUCER (CT) PROGRAMMING LOGIC: All new constant speed fan motors and pumps shall have analog current transducers (CT) which provide a continuous amp draw signal. The normal amp draw for each constant speed motor shall be recorded and stored AFTER test and balancing is complete. Program a high limit alarm when current is 25% higher than "normal" for 5 minutes. Program a low limit alarm when current is 50% of "normal" for 5 minutes. The low limit shall be used for proof of flow. If amp draw is below low limit then either flow is very low, or a fan belt broke.

N. PREDICTIVE MAINTENANCE TRENDING GRAPH: For all fixed speed motors with analog current transducers, continuously calculate a 30-day average of motor amp draw (record amp draw only when motor is on). Compare the actual motor amp draw with the 30-day average. If the actual amp draw is 10% higher (adjustable) than the 30-day trailing average, then provide a low-level alarm for "high motor amp draw – anticipate failure". A high amp draw is a prediction of motor or bearing failure.

O. EMERGENCY POWER SOURCE. If only selected equipment and systems are to run on emergency power, then the power source for those control devices shall originate from emergency power.

P. HOT AND CHILLED WATER EMERGENCY POWER. If only portions of the hot or chilled water systems are intended to operate during emergency power, then spring-return closed valves shall be used on non-emergency powered water valve actuators. This is to direct the water to only the intended usage. Fewer branch line spring-return closed isolation valves can be substituted for many coil valves.

3.04 GRAPHIC DISPLAYS AT OPERATOR INTERFACE

A. Create graphical display pages for the equipment and systems on the project, including but not limited to the following. Refer to other paragraphs for specific requirements for data points.
   1. Air handling/Rooftop units
   2. Central plants – including (chilled water plants, hot water heating systems, heat exchanger systems, water source heat pump systems, etc)
   3. VAV box summary table (see description)
   4. Reheat coil summary table (see description)
   5. Air filter summary table (see description)
   6. Fan coil units
   7. Supply and exhaust fans
   8. Smoke control systems

B. Provide floor plan graphic screens which represent the location of the equipment, for click-through of that equipment.

C. Floor plans shall also include data points for space temperature setpoints and measured values. Each room on the floorplan shall be mapped to a color-coded reference chart which displays the measured room temperature in color. There shall be two color coded temperature maps for the floorplans – the first for measured temperature, and the second for difference between the temperature setpoint and the measured temperature. The color code shall be darker blue for cooler rooms, yellow for comfortable rooms, and orange/red for progressively warmer rooms. The same color scheme of shades of blue for colder rooms and shades of red for warmer rooms shall be used for the differential temperature map of the difference between setpoint and actual measurement temperature.

D. Provide a link on each graphic page to the written sequence of operations for that system or piece of equipment.

E. Provide a time/date stamp on the graphic display so it will be shown when captured and printed.

F. Provide a graphical representation for each piece of equipment controlled. Display all sensor points in appropriate locations to the actual placement of the sensors. Provide on/off/position indications for motors, actuators, etc. Display the set points for various control loops adjacent to the actual sensor readings, such as supply air temperature set point and actual temperature, pre-heat coil temperature set point and actual temperature, etc. If the control loop is ‘off’, such as pre-heating, then show ‘off’ in the set point display box. Provide a direct link to a floor plan of the building with the area served by the AHU highlighted. Provide a direct link to the Filter Status page.

G. For each piece of equipment, provide a photo-link to a digital photo (or multiple photos for larger pieces of equipment) of the piece of equipment shown in the graphical display.

H. Provide a “Maintenance” screen link to each piece of equipment and system which allows the Owner to input and manage maintenance related items for each piece of equipment. The Maintenance screen shall include data fields for the owner to input make/model numbers for items such as fan belts, motor sizes, filter sizes and quantities, oil type, etc., as well as date field for recording servicing dates.

I. The graphic screen development for equipment and systems shall include displayed data points for the values listed in the various paragraphs. When a particular equipment graphic screen gets too cluttered, it is acceptable that a second page be utilized for the displaying of the non-critical (but still required and desired) data points. In all cases where there is a setpoint variable used in a control algorithm, the associated measured value shall also be displayed to provide the operator with a visual indication of the accuracy of the PID control loop operation.

3.05 PACKAGED EQUIPMENT CONTROLS INTERFACE

A. It is common for project equipment from manufacturers to have self-contained controls and microprocessor logic such as packaged roof top units, container type humidifiers, some VAV boxes, chillers, etc. The self-contained equipment's controls shall be 'connected' and integrated into the overall control system for the project. Internal data points related to operation shall be pulled from the self-contained control system so that the operator can view operating data points at the BAS workstation. And key adjustable operating setpoints such as temperatures and pressures shall be able to be input into the self-contained equipment's control system.

B. If equipment substitutions are made, then the equipment's self-contained control package shall include the control logic and sequence capabilities described in the subsequent paragraphs. Not all features will be available from all manufacturers, which means the controls contractor may have to provide supplementary control logic on stand-alone controllers to meet the sequence of operations design intent.

3.06 VARIABLE FLOW EQUIPMENT IN PARALLEL

A. When variable flow fans or pumps are arranged for parallel flow, the variable speed drives for those motors shall be synchronized to run at the same speed.

B. For parallel fans and pumps, the operating pressure setpoint logic shall be determined in multiple equipment level controllers, or in a separate wall-mounted controller. Turning off one AHU, fan or pump for maintenance shall not interrupt the variable speed of the remaining units. Daisy-chaining from one variable speed drive to another is not acceptable since turning off the lead drive will disrupt the signal to the downstream drives.

3.07 GLOBAL AND LOCAL CONTROL

A. The local control system is defined as the hardware and software for a piece of equipment or a sub-system to operate properly. For example, an air handling unit and associated remote temperature sensors, and static pressure sensors is considered a local control system.

B. The global control system is the overall network which connects the local control systems together and connects them with a master controller with global oversight.

C. The local control systems shall be installed and set-up to operate properly in both stand-alone mode as well as normally connected to the global control system. During system commissioning, stand-alone operation shall be validated by disconnecting the global network connection and observing the equipment operating normally – or in a special stand-alone mode if specified.

D. If no stand-alone mode is specified, then the stand-alone mode for the equipment/system shall be the current mode of operation when the global network connection as lost.

3.08 AIR SIDE SYSTEM AND EQUIPMENT BASIC CONTROL REQUIREMENTS

A. General Requirements. The following basic features shall be included for every air handling unit, blower coil unit, and fan-coil units. These basic items are not duplicated in subsequent sections. For units without a specific device or mode, such as no heating capability, then that mode is obviously not required.
   1. START/STOP. Each air handler and controls shall be enabled / disabled by the BAS. Unit controls shall operate automatically when energized.
   2. NORMALLY ON/OFF. The normally OFF (disabled) status shall be: fans off, smoke dampers closed, return air damper open, outside air damper closed, chilled water valve closed, hot water valve closed. The normally ON status shall be: fans on and outside air dampers enabled, chilled and hot water valves enabled.
   3. OUTDOOR AIR DAMPER ACTUATORS: All outdoor air damper actuators shall be modulating type spring return CLOSED, so they will close automatically on loss of utility or

control power. 100% outdoor air units can have 2-position damper actuators, with spring return closed.

4. MINIMUM OA. The outside air volume shall be set up (with TAB) as a minimum damper position during occupied periods - along with active means of controlling the OA volume in VAV systems according to ASHRAE 62 or Title 24 requirements.
5. FIRE ALARM SHUTDOWN RELAY: A relay from the fire alarm system shall initiate a contactor in the AHU fan starter or VFD which turns off the AHU fans upon an alarm signal from the fire alarm system.
6. DUCT SMOKE DETECTORS: The Electrical division shall provide duct smoke detectors (compatible with their fire alarm system) for installation by the Mechanical. The fire alarm contractor shall be responsible to wire the devices to the fire alarm system.
7. INTERCONNECTS: Associated exhaust and supply fans shall be started and stopped through control power from the load side transformer for their respective air handling systems. If supply fan fails proof of flow, then the associated exhaust fans shall turn off, and zone smoke dampers shall lose power and spring closed.
8. OCCUPIED MODE: Provide an Occupied mode of operation for each unit. During the Occupied mode, the unit shall operate according to the listed sequences of operation, but generally the outside air damper shall be open to provide minimum outdoor ventilation and the active set points shall be set to the occupied set points. The AHU supply fans shall operate continuously in occupied mode.
9. UNOCCUPIED MODE: Provide an Unoccupied mode of operation for each AHU. In general, the outside air damper shall be closed, and the active set points shall be set to the unoccupied set points. When the space temperatures exceed the unoccupied high and low limits, then the AHU shall be enabled (with the OA damper closed) until the space temperatures are met. The AHU supply fan shall not run during deadband mode between the high and low temperature limits. The unoccupied high space temperature limit shall be initially set to 80F, and the low limit set to 60F. The outside air damper may open during unoccupied mode if economizer cooling is possible.
10. HEATING MODE: When the space temperature falls below the active heating set point, the controller shall enable the heating sequence. Once the temperature rises above the setpoint plus the deadband (2 degrees (ADJ)) then the unit will enter deadband mode.
11. COOLING MODE: When the space temperature rises above the cooling set point, the controller shall sequence the stages of cooling to maintain space temperature set point. Once the temperature falls below the setpoint minus the deadband (2 degrees (ADJ)) then the unit will enter deadband mode.
12. DEADBAND MODE: In deadband mode, between a high and low setpoint, neither heating or cooling shall be enabled.
13. PRE-HEAT RESET. The pre-heat coil leaving air temperature setpoint shall be a derived value of the main unit Supply (not coil leaving) air temperature low limit setpoint (usually 54F or 55F) minus 5F. The intent is to provide a deadband between heating and cooling coil temperatures to avoid simultaneous operation, and to account for some fan reheat.
14. DEHUMIDIFICATION MODE: When the space humidity exceeds the high humidity set point of 60%, then the unit shall enter dehumidification mode – which is basically suspending the supply air reset schedule and returning the supply air setpoint back to the base value. The unit shall remain in dehumidification mode for an adjustable period of time, starting at 30 minutes.
15. MINIMUM OUTSIDE AIR VOLUME SETPOINT: Every AHU shall have the OA damper configured for a specific position for minimum OA ventilation air. The TAB contractor shall assist in verifying airflows and damper positions.

3.09 GENERAL AIR HANDLING UNIT CONTROL SEQUENCES

A. This section describes the requirements and sequences for the various components used on air handling units. Refer to the control diagrams for the layout of the various components and the related control sequences.

B. GRAPHICS. The main graphics page for the air handling units shall include all physical equipment, virtual modes of operation, variable values, etc. Remote system data shall be pulled in and displayed along with local alarms including the following:
   1. Outside air temperature from remote sensor if necessary
   2. Outside air humidity from remote sensor if necessary
   3. Mixed air temperature
   4. Local alarms: low temperature, equipment failure, high pressure, etc.

C. RETURN AND EXHAUST FAN GRAPHICS. The speed control method is listed in another paragraph. Provide the following additional control connections: binary input for VFD alarm, analog input for VFD speed monitoring, analog input for VFD kW power consumption. The kW power consumption shall be used for proof of flow. Graphic Points:
   1. Fan Start/Stop
   2. VFD commanded speed
   3. VFD speed feedback
   4. VFD status
   5. Amps/kW – Bar graph with marks identifying normal with new and loaded filters
   6. Minimum RF Amps
   7. Fan Proof of flow – Graphic showing fan rotating
   8. Static Pressure
   9. Static Pressure Set Point (Adjustable)

D. AHU COIL TEMPERATURE RESET. The main supply air temperature setpoint (leaving the AHU, not the coil) shall be the controlling temperature for heating and cooling coils in the AHU. The coil leaving temperature sensors are generally for monitoring, not necessarily control. The main supply air temperature sensor and setpoint (generally called T1 on the control diagrams) shall be used to provide control input to the coil logic. For draw-through AHU's, the cooling coil leaving air temperature scheduled on the drawings includes provisions for a few degrees of supply fan heat. So a desired 55F supply air temperature is generally achieved with a leaving cooling coil temperature of 51-53F, and the sensors shall be configured to show that operation.

E. SIMULTANEOUS HEATING AND COOLING CONTROL. In most modes of operation, simultaneous heating and cooling is not necessary. It may be necessary in certain modes such as high-humidity control mode, or precision environmental control such as laboratories. Include control logic, or appropriate temperature setpoint offsets to prevent unnecessary simultaneous heating and cooling.

F. DX COOLING. The DX capacity shall be staged (or modulated) by the supply air temperature logic of the air handling unit. When the supply air temperature is above the set point, the cooling stages shall increase to maintain the set point. Calculate the cooling stages capacity to affect the air temperature (typically +/-5F) and include an offset in the supply air temperature reset schedule to prevent short cycling. The supply air temperature set point will vary based upon reset schedule. If the packaged controller does not have supply air temperature reset capability, then the controls contractor shall provide a separate control device to reset the packaged unit's supply air temperature setpoint. If the cooling coils have split-face coils, then the controls contractor may have to modify the packaged control sequence to ensure both coil sections are always on (to prevent unconditioned bypass air) or add a face/bypass damper to the lag coils. In no circumstances shall air be allowed to flow through an 'off' coil section. Graphic Points:
   1. Cooling Coil Leaving Air Temp
   2. Cooling Coil temperature setpoint (reset)
   3. Pre-treated outside air temperature if applicable.
   4. Supply Air Temperature
   5. Supply Air Temperature Set Point
   6. Cooling stages/capacity commanded position
   7. Cooling stages/capacity operating

G. FILTER PRESSURE MONITORING: Provide differential pressure sensors (not switches) for all individual filter sections, pre and final. Observe and set clean fliter pressure drop setpoint during startup (with clean filters). The dirty setpoint shall be initially set to 2x the clean setpoint – or as otherwise listed in the equipment schedule, or as directed by the engineer. Both clean and dirty values shall be a displayed in the AHU graphic screen. Dirty setpoints shall not exceed the manufacturer's maximum pressure rating for the filters. For guidance, pre-filters usually shall not exceed 0.45" (the frames will collapse), and 90%-99% filters usually shall not exceed 1.3". Refer to the Filter Status Programming paragraph for more information.
   1. Graphic Points:
      a. Current Filter Pressure Drop for Each Bank
      b. Dirty Limit for Each Bank
      c. Dirty Filter Alarm for Each Bank
   2. Substitution requirement for DP Switches: If a post-bid cost cutting substitution of DP switches is proposed in lieu of DP sensors, then the following setup labor and costs shall be included in the substitution scope of work:
      a. Field measurement of clean filter pressure drop. Calculation of 2x clean pressure drop for dirty pressure drop, in lieu of specific direction found in equipment schedules.
      b. Manual set-up of pressure switch 'dirty' pressure setting using a Magnehelic gauge.
      c. Hand-write with a permanent marker the pressure value (e.g. 0.45 in. w.g.) that the switch contact closure was set to on or nearby the physical switch itself.

H. TERMINAL HW REHEAT COILS. Associated downstream duct reheat coils shall be interlocked with air handler to energize reheat controls with air handler operation. Reset the supply air temperature set point to maintain space temperature. Modulate the hot water valve to maintain supply air temperature set point. Provide room sensors with occupant set point adjustment for reheat coils and limit adjustment from 66°F to 74° F. (note low temperature setting on reheat system actually saves energy because reheating is minimized). Supply air temperature set point information is utilized by the air handler controller for discharge air temperature control.
   1. Graphic Points:
      a. HW Valve position
      b. Space temperature
      c. Space temperature set point
      d. Supply air temperature
      e. HW supply temperature (from Boiler Plant)
      f. HW supply set point (from Boiler Plant)
   2. "Special Space" Terminal Reheat Cascade Control
      a. Cascade control shall be used for special spaces requiring precise temperature control including: Operating rooms, IT/server rooms, animal rooms, etc.
      b. Provide a wall temperature adjustment device, with the remote temperature sensor located downstream of the reheat coil in the supply duct. The close proximity of the sensor to the reheat coil serves to reduce reaction time and reduce valve hunting.

I. TERMINAL OR DUCT ELECTRIC REHEAT COILS. Associated downstream duct reheat coils shall be interlocked with air handler to energize reheat controls with air handler operation. Stage the electric heat to maintain space temperature at setpoint. Provide room sensors with occupant set point adjustment for reheat coils and limit adjustment from 66°F to 74° F. (note – a lower low temperature setting on reheat system actually saves energy because reheating is minimized).
   1. Graphic Points:
      a. Space temperature
      b. Space temperature set point
      c. Leaving air temperature
      d. Stage or capacity of heat energized
   2. "Special Space" Terminal Reheat Cascade Control
      a. Cascade control shall be used for special spaces requiring precise temperature control including: Operating rooms, IT/server rooms, animal rooms, etc.

b. Provide a wall temperature adjustment device, with the remote temperature sensor located downstream of the reheat coil in the supply duct. The close proximity of the sensor to the reheat coil serves to reduce reaction time and reduce valve hunting.

J. VAV TERMINALS WITH REHEAT COIL. Associated downstream VAV terminals with reheat coils shall be interlocked with air handler to energize terminal box controller with air handler operation. Modulate the terminal box damper to maintain space temperature set point. Upon an increase in space temperature, the terminal box damper shall modulate open. Upon a decrease in space temperature, below set point, the terminal box damper shall modulate closed, towards its minimum open position. If the terminal box damper is at its minimum open position for 5 minutes and space temperature is not satisfied, the terminal box damper shall open to its heating position and heating coil shall modulate to maintain space temperature set point. Provide room sensors with occupant set point adjustment and limit adjustment from 66°F to 74°F. VAV damper position, space temperature and set point information is utilized by the air handler controller for discharge air temperature control and static pressure set point. Graphic Points:
   1. Heating or Cooling Mode
   2. Space Temperature
   3. Space Temperature Set Point
   4. VAV Box Supply Air Flow (CFM)
   5. VAV Box Damper Position (percent open)
   6. Space Humidity (as applicable)

K. HOT WATER RE-HEAT COIL. The re-heating coil control valve shall have a setpoint which can be modulated by the supply air temperature logic of the air handling unit, or by a space temperature sensor if it is a single zone unit. The re-heat coil discharge temperature setpoint shall be reset by the supply air temperature reset logic. (if the re-heat coil is the last process, then the re-heat temperature and the supply air temperature values would be the same) The re-heat temperature setpoint shall then be adjusted up or down based upon the supply air temperature reset logic (or space sensor). There may be a high humidity limiting control logic mode which over-cools for moisture removal – in that mode the re-heat coil would be enabled to operate normally by the supply air temperature setpoint (to prevent overcooling). The user shall not have to adjust the re-heat setpoint, it shall be managed entirely by the offset from the supply air reset logic, or the space setpoint. In ECONOMIZER mode, the re-heat coil shall be Off. The HW reheat Return Temperature sensor leaving the coil is one of the most valuable points used for verifying proper operation, and for troubleshooting problems – it shall not be eliminated in post-bid cost reduction exercises. Graphic Points:
   1. HW Re Heat Coil Leaving Air Temp
   2. HW Re-heat coil temperature setpoint (reset)
   3. Space temperature (if single zone unit).
   4. Supply Air Temperature (can serve as reheat coil discharge sensor too if it the last device)
   5. Supply Air Temperature Set Point
   6. HW Valve commanded position
   7. HW Valve Feedback
   8. HW Valve Feedback Alarm
   9. HW Return Temperature (leaving the coil)
   10. HW Supply Temperature (from Boiler Plant)
   11. HW Supply Set Point (from Boiler Plant)
   12. Design HW Delta T

L. ELECTRIC PRE-HEAT COIL. The pre-heating coil control will have stages or variable (SCR) control based upon equipment selections. The pre-heat coil shall have a setpoint which can be modulated by the supply air temperature logic of the air handling unit. The pre-heat coil discharge temperature setpoint shall be initially calculated to be the cooling coil leaving air temperature setpoint minus 5F (52F – 5F = 47F). The pre-heat temperature setpoint shall then be adjusted up or down based upon the supply air temperature reset logic. Maintaining a temperature offset will

prevent simultaneous pre-heating and cooling. The user shall not have to adjust the pre-heat setpoint, it shall be managed entirely by the offset from the supply air reset logic. In ECONOMIZER mode, the pre-heat coil shall be Off. The pre-heat coil shall have low limit freeze prevention logic to engage the pre-heat coil to maintain >40F during all modes of operating including Economizer, a low-level alarm shall alert the operator that a low temperature problem exists. For staged heaters, it is likely that the temperature shall overshoot and undershoot the setpoints, so provide minimum runtime variables to prevent fast cycling. Graphic Points:

1. Pre Heat Coil Leaving Air Temp
2. Pre Heat Coil Setpoint (reset)
3. Pre-treated outside air temperature if applicable.
4. Supply Air Temperature
5. Supply Air Temperature Set Point
6. Pre Heat Stages or % capacity
7. Low Limit Temperature Alarm (>40F)

M. ELECTRIC RE-HEAT COIL. The re-heating coil control will have stages or variable (SCR) control based upon equipment selections. The re-heat coil shall have a setpoint which can be modulated by the supply air temperature logic of the air handling unit, or by a space temperature sensor if it is a single zone unit. The re-heat coil discharge temperature setpoint shall be reset by the supply air temperature reset logic. (if the re-heat coil is the last process, then the re-heat temperature and the supply air temperature values would be the same) The re-heat temperature setpoint shall then be adjusted up or down based upon the supply air temperature reset logic (or space sensor). There may be a high humidity limiting control logic mode which over-cools for moisture removal – in that mode the re-heat coil would be enabled to operate normally by the supply air temperature setpoint (to prevent overcooling). The user shall not have to adjust the re-heat setpoint, it shall be managed entirely by the offset from the supply air reset logic, or the space setpoint. In ECONOMIZER mode, the re-heat coil shall be Off. Graphic Points:

1. Re Heat Coil Leaving Air Temp
2. Re-heat coil temperature setpoint (reset)
3. Space temperature (if single zone unit).
4. Supply Air Temperature (can serve as reheat coil discharge sensor too if it the last device)
5. Supply Air Temperature Set Point
6. Re-heat stages or % capacity

N. GAS HEATING: Gas heat shall be enabled during heating mode and proof of flow from supply fan. The heater shall have a setpoint which can be modulated by the supply air temperature logic of the air handling unit, or by a space temperature sensor if it is a single zone unit. The heater discharge temperature setpoint shall be reset by the supply air temperature reset logic. (if the heater is the last process, then the re-heat temperature and the supply air temperature values would be the same) The heater temperature setpoint shall then be adjusted up or down based upon the supply air temperature reset logic (or space sensor). There may be a high humidity limiting control logic mode which over-cools for moisture removal – in that mode the re-heat coil would be enabled to operate normally by the supply air temperature setpoint (to prevent overcooling). The user shall not have to adjust the re-heat setpoint, it shall be managed entirely by the offset from the supply air reset logic, or the space setpoint. For single zone systems, the supply air temperature set point shall be reset between high, and low limts of 120F and 80F (ADJ), to maintain space temperature and the firing rate shall be modulated to maintain supply air temperature at set point. For multi-zone systems, the supply air setpoint (including SATR) shall control the heating setpoint. If supply air temperature exceeds the high limit of120F then the heating shall be disabled until manually reset. Graphic Points:

1. Cooling Coil Leaving Air Temperature (Entering heating coil)
2. Supply Air Temperature
3. Supply Air Temperature Set Point
4. Supply Air Temperature Set Point Low Limit
5. Supply Air Temperature Set Point High Limit

6. Supply Air Temperature Set Point High Temperature Alarm
7. Heater leaving air temperature
8. Space Temperature (if single zone)
9. Space Temperature Heating Set Point. (if single zone)

O. ECONOMIZER MODE: If waterside economizer is provided, then airside economizer may not be required. In some constant volume systems where relative room pressure difference is critical (e.g patient areas) economizer mode would be detrimental. If airside economizers are required, then provide control logic to mix the OA and RA to the supply air temperature reset value to minimize mechanical cooling, using a Mixed Air temperature sensor and setpoint reset. A comparative enthalpy switchover logic is generally used to turn on/off the economizer mode. Economizer mode shall be enabled when the OA enthalpy is less than the RA enthalpy. The mixed/return air and OA damper actuators shall operate inversely. As the mixed air temperature drops, the OA damper shall modulate from open to the minimum ventilation position. When the minimum ventilation position is reached, then Economizer mode can be turned Off to allow the pre-heat coil to operate normally. Relief may or may not be actively controlled. In some arid regions, the contractor may substitute dry bulb temperature comparative enthalpy control methods for review and approval. Ensure the temperature/humidity sensors for the enthalpy controller are in locations with active airstreams to continuously measure differences between the OA and RA conditions. Graphic points:
   1. Economizer Mode on/off (based upon comparative enthalpy switchover logic)
   2. Economizer enthalpy temperature values if approved for temperature control
   3. Mixed Air temperature setpoint, based upon offset from Supply air temperature reset value.

P. OCCUPIED MODE. When indexed to the occupied mode (either automatically, or manually overridden) the supply air fan shall be enabled, and the various components of the AHU shall be enabled. In occupied mode the OA damper shall be enabled Open to bring in ventilation air for the occupants.
   a. Heating Mode – When the space temperature falls below the heating set point, the controller shall sequence the stages of heating to maintain space temperature set point.
   b. Cooling Mode – When the space temperature rises above the cooling set point, the controller shall sequence the stages of cooling to maintain space temperature set point.
   c. Dehumidification Mode – When the space humidity exceeds the high humidity limit of 60%, then dehumidification model shall be enabled. Dehumidification mode shall operate until the relative humidity drops below 56% or after 30 minutes. There shall be a 10-minute time delay before the system can re-enter dehumidification mode. Dehumidification mode is essentially lowering the cooling coil leaving temperature to its lower design point to remove moisture from the airstream, thereby lowering the space relative humidity. The control logic may include stages of heating to prevent overcooling the space – which drives up the relative humidity even farther.
   d. High and Low Occupied Temperature Setpoints. The space setpoints are generally user adjustable within a pre-defined range of temperatures – for normally occupied spaces. Initially limit user adjustability between a low of 72F and a high of 78F. After occupancy, it is expected that some of the sensors limits will need to be adjusted. For normally unoccupied spaces such as electric rooms, provide a higher high limit of 80F.

Q. UNOCCUPIED MODE. When indexed to the unoccupied mode (either automatically, or manually overridden), the supply fan shall be disabled, and the unit shall essentially shut down. Ensure all OA/relief dampers and smoke/isolation dampers are closed
   a. Heating Mode – When a space temperature falls below the unoccupied space temperature heating set point, the supply air fan shall be enabled. The various modes of heating shall be enabled to achieve the unoccupied space temperature set point. The outside air damper shall remain fully closed and the return air damper shall remain fully open.

b. Cooling Mode – When the space temperature rises above the unoccupied space temperature cooling set point, the supply air fan shall be enabled. The stages of cooling shall be enabled to achieve the unoccupied space temperature set point. The outside air damper shall remain fully closed and the return air damper shall remain fully open.
c. High and Low Unoccupied Temperature setpoints. The AHU shall be off when the space temperatures are in the deadband between the High and Low temperature setpoints. When the temperature exceeds the High and Low setpoints – the AHU shall be enabled with the intention of serving only the outlying space if possible. The High and Low Unoccupied space temperature setpoints shall be adjustable, and shall initially be set to the following for normally occupied spaces:
    1) High: 80F occupied space.
    2) Low: 60F

R. DEHUMIDIFICATION MODE. When return air (or space) humidity sensor reads above high humidity setpoint of 60% (adjustable, but limited between 55% and 70%, unless specified otherwise for a special space)), then the supply air temperature reset shall be reset back to the design setpoint (typically 55°F), and the supply air temperature reset logic shall be disabled for 30 minutes (adjustable). Graphic Points:
1. Dehumidification mode status.
2. Humidity reading of space and return humidity sensors.
3. Supply Air temperature reset set point.
4. Supply air temperature.
5. Dehumidification mode timer status.
6. High humidity setpoint (limit user adjustability between 60% and 70%)

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S. FIRE ALARM SHUTDOWN. Electrical shall provide an addressable fire alarm shut down relay to be installed in the AHU starter control circuit which shuts down the AHU on a call from the fire alarm system. When the fire alarm system commands the AHU to shut down, associated smoke dampers shall lose power and spring return close, and associated exhaust fans shall turn off.

T. DUCT SMOKE DETECTORS. Duct smoke detectors compatible with the fire alarm system shall be furnished by Electrical. Install duct smoke detectors in the supply and return duct (prior to any branch ducts) of air handling units with capacity greater than 2,000 cfm, or as required by local code.

U. FREEZE PROTECTION – FREEZESTAT. A low temperature cutoff type switch shall be used to stop the fan when the serpentine sensing element senses temperatures below the setpoint. The setpoint shall initially be 35°F. The device shall be manually reset. The sensing element shall not be less than one linear foot per square foot of coil surface area. The sensing element shall be installed on the downstream side of the coil.

V. FREEZE PROTECTION – SOFT PROTECTION. When any water coil leaving air temperature sensor detects a temperature below 40°F, then the outside air damper shall close, the water valve shall open, and send a high priority alarm. If the air temperature is below 35°F for more than 15 minutes, then disable the air handling unit, and send a high priority alarm. Graphic points:
1. Freeze protection status (normal, soft protection mode, shutdown mode).
2. Freeze protection alarm.

W. TRENDING. Set up the following trends for the AHUs. For each trend group, provide trend durations as indicated.
1. Temperature Performance. Daily and Monthly. Store data collected every 30 minutes (adjustable). Ensure data storage device is large enough to handle at least 2 years of data collection.
    a. Outside air temperature
    b. Return air temperature

c. Mixed air temperature
d. Return air humidity, or space humidity
e. Pre-heat coil leaving air temperature
f. Cooling coil leaving air temperature
g. Supply air temperature
h. Supply air temperature reset value

X. ALARMS. Provide low priority alarms for the following items in addition to the standard high and low priority alarms listed in the alarm requirements.
1. 'Low supply duct static pressure.' When the fan is On and the measured supply duct static pressure is more than 0.2" below the setpoint for more than 30 minutes.
2. 'Low chilled water return temperature' when the coil leaving chilled water temperature is below 52°F for more than 30 minutes, and the cooling coil is enabled. (this is a low delta-T prevention alarm)
3. 'High leaving chilled water temperature' when the leaving chilled water temperature is higher than 64°F for more than 30 minutes, and the cooling coil valve is enabled. (this is preventive maintenance alarm that either the coil strainer is clogged, heating is improperly enabled, or the inlet air temperatures are out of bounds)

3.10 DX VARIABLE AIR VOLUME AHU

A. In addition to the Basic and General requirements listed in previous paragraphs, provide the following items specific to this type of operation

B. PACKAGED CONTROLS. The intent for this section is for the equipment manufacturer to furnish a controls package with options necessary to meet the controls design intent. The controls contractor is responsible to provide supplemental control devices and logic to meet the controls design intent. Consult with the engineer before modifying packaged microprocessor control logic.

C. MINIMUM DX COIL AIRFLOW. The controls contractor shall coordinate with the (successful) equipment manufacturer to verify the minimum DX coil airflow volume to prevent freezing or improper operation. The minimum coil airflow shall be programmed into the VAV boxes to ensure the minimum airflow across the DX coil – these minimums may supersede the VAV box schedule, since different manufacturers will have different required minimums.

D. BASIC OUTSIDE AIR MIN VENTILATION CONTROL FOR VARIABLE VOLUME. ASHRAE 62 and California's Title 24 do not allow traditional fixed OA damper positioning for VAV systems (in non-economizer mode) because the OA volume varies across the range of the supply fan's volume. If the air handling unit is VAV, and there is no return or exhaust fan, then it must have basic control capability to comply with ASHRAE 62 or Title 24. The following are methods for control. If an OA air flow measuring station is not furnished with the equipment, then method 1 is the default method for controlling minimum OA volumes, otherwise use method 2.
1. Basic OA: The control devices and logic may exceed the capacity of a packaged controller from the manufacturer, and in that case the controls contractor is responsible for supplemental devices, wiring, and logic. A differential pressure sensor shall measure the DP across the outside air damper. Setup – the TAB and controls contractor shall adjust the OA damper position and return air damper position (provide RA damper if not included in basic manufacturer's equipment) for minimum VAV supply air flow. This is the minimum air flow DP setpoint. The same adjustment shall be made for maximum VAV supply airflow – to adjust the OA and RA damper position in order to get the minimum required OA volume. This is the maximum air flow DP setpoint. A linear relationship can be made between the fan speed at min and max and the OA/RA damper position at min and max, so the dampers are positioned according to the fan speed. NOTE: this may require upgrading the AHU manufacturer provided damper actuators.
2. Air Flow Measuring Station: An air flow measuring station is used on the OA airstream to control the OA damper to the minimum ventilation position during non-economizer modes.

E. SPECIAL OUTSIDE AIR VENTILATION CONTROL FOR VARIABLE VOLUME. ASHRAE 62 and California's Title 24 do not allow traditional fixed OA damper positioning for VAV systems (in non-economizer mode) because the OA volume varies across the range of the supply fan's volume. If the air handling unit is VAV, and there is no return or exhaust fan, then it must have basic control capability to comply with ASHRAE 62 or Title 24. Both of the following methods are acceptable. Refer to the drawings for clarification.
   1. 2-Damper OA: This method uses two dampers for outside ventilation air, typically used for larger volume systems with high a high turndown between full economizer and min OA volumes. A smaller damper is used for minimum ventilation air requirements and a larger damper for economizer mode. Use the same setup method in the Basic OA paragraph for establishing the linear relationship between the min and max supply airflows and the min and max OA/RA damper positions. When the economizer mode is enabled, both OA dampers can modulate together with the same output signal. In non-economizer mode, the larger economizer damper is closed.
   2. Injection OA: This method used air supplied from some other fan powered source (such as a heat recovery wheel, or a pre-conditioning AHU). Typically no additional local control is necessary other than to potentially open/close an OA isolation damper. Refer to control diagrams for clarification.

F. CO2 DEMAND CONTROLLED VENTILATION (DCV). ASHRAE 62 Appendix C allows for CO2 based demand control ventilation. If a CO2 sensor is shown on the control diagram, then the following sequence is allowed to reduce the minimum scheduled ventilation rate to more economically match the actual occupancy using CO2 as a proxy for occupant effluent. The assumption is the outdoor CO2 concentration is 400 ppm..
   1. The high level setpoint for the occupied space CO2 sensor shall be 700 ppm higher than the actively measured outdoor air CO2 concentration or 1,100 ppm if an outdoor CO2 sensor is not shown. When the occupied CO2 space concentration is less than the high level, then enable DCV mode. In DCV mode the OA damper shall be allowed to modulate more closed reducing the minimum scheduled outdoor air volume.
   2. If not scheduled, a DCV minimum OA rate shall be established equal to ½ of the normal schedule OA rate.
   3. The reduction of OA volumes may affect the building pressurization balance. Review exhaust methods associated with DCV AHU's. When DCV is enabled, an associated exhaust fan may require DCV control logic.

G. SUPPLY FAN VFD SPEED CONTROL FOR VARIABLE VOLUME. A duct mounted differential static pressure sensor shall provide the input signal to the VFD to control the fan speed to maintain the duct static pressure setpoint. Coordinate with TAB contractor to set up and adjust for proper duct static pressure setpoint – using simulated 'dirty' filter pressure drops. The location of the static pressure sensor shall be approximately 2/3 down the duct for VAV systems, and placed in an easily accessible location (bottom side of duct) for calibration and servicing. Provide the following additional control connections: binary input for VFD alarm, analog input for VFD speed monitoring, analog input for VFD kW power consumption. The kW power consumption shall be used for proof of flow. Graphic Points:
   1. Supply Fan Start/Stop
   2. VFD commanded speed
   3. VFD speed feedback
   4. VFD status (alarms, etc)
   5. Amps/kW – Bar graph with marks identifying normal with new and loaded dirty filters
   6. Minimum SF Amps
   7. Fan Proof of flow – Graphic showing fan rotating
   8. Duct Static Pressure
   9. Duct Static Pressure Set Point (Adjustable) (0.01 in w.g. accuracy)

H. EXHAUST FAN SPEED CONTROL FOR VARIABLE VOLUME. This arrangement includes control logic for the exhaust fan speed and the Exhaust (or Relief) damper. The exhaust fan is only enabled during economizer mode, and off during non- economizer mode.
   1. In economizer mode, the exhaust air damper shall be opened fully. A backdraft exhaust damper may be used for some packaged units.
   2. In economizer mode, the exhaust fan shall be enabled and controlled to maintain a static pressure setpoint measuring the difference between the outdoors and a common/general interior space. The DP setpoint shall be initially set to +0.02 in .w.g., and adjusted by TAB to achieve slightly positive building pressurization in that zone.

I. SUPPLY AIR TEMPERATURE RESET – VAV NO REHEAT. Provide supply air temperature reset (SATR) control. The supply air temperature setpoint shall be reset based upon the downstream terminal unit demand for cooling. A space or return duct humidity sensor shall be used to override the supply air temperature reset logic for high humidity control mode. The downstream terminal units shall be polled to see whether any is near full cooling. If none are in full cooling, then the supply air temperature setpoint can be raised 0.5F degree. After a 5 minute delay, the downstream terminal units shall be polled again. If one is in full cooling, then lower the supply air temperature 0.5F. If none are in full cooling, then raise the supply air temperature up 0.5F. The design supply air temperature shall be 55°F (unless scheduled otherwise) on startup, and shall be reset based upon terminal unit demand. Any space or return air humidity sensor shall override supply air reset for 30 minutes (adjustable) when the space humidity rises above the adjustable high limit set point 60% RH. Graphic Points:
   1. VAV box number calling for highest % cooling.
   2. Supply Air temperature set point. (max of 62F, min of scheduled cooling coil LAT + 2F)
   3. Supply air temperature.

J. STATIC PRESSURE RESET. In lieu of SATR the controls contractor may rely upon the packaged controls option for static pressure rest for energy optimization. Static pressure reset mode shall be engaged during both occupied and unoccupied modes. The static pressures at every VAV box shall be polled, and the static pressure setpoint shall be reset up or down to meet the minimum pressure requirement for the VAV box(es) in the full minimum or maximum positions.

K. ECONOMIZER. Provide economizer mode.

3.11 EXHAUST FANS - GENERAL

A. In addition to the Basic and General requirements listed in previous paragraphs, provide the following items specific to this type of operation.

B. The controller shall initiate an alarm under the following conditions:
   1. Exhaust fan failure

C. EXHAUST FANS ASSOCIATED WITH AHU'S: When the intent is for exhaust fans in an AHU zone to balance the outside air volumes, the exhaust fan shall be enabled with the "associated" air handling unit is enabled. When its associated air handling unit is off, the exhaust fan shall be off. The controls requirement is for the exhaust fan starter control circuit to be connected to the associated AHU starter circuit – so when the AHU is turned off (either remotely or manually), then the exhaust fan's control circuit loses power and turns off too.

D. SCHEDULED OPERATION: When the exhaust fan operation is by occupancy schedule, the BAS time of day schedule and occupancy modes shall turn on and off the exhaust fans.

E. SWITCHED FANS: Provide on/off control for exhaust fans on manual switches.

F. HEAT RELIEF FANS: Provide a standalone reverse acting thermostat to turn on the exhaust fan when the space temperature is above the setpoint. Include associated devices such as damper actuators.

3.12 FAN COIL UNIT OCCUPANCY SENSORS

A. OCCUPANCY SENSOR: If the drawings include occupancy sensors, a push-button override, lighting controls, door switches, or other remote control device, then this section shall supplement the basic controls included in the separate fan coil unit section.

B. SPACE SENSOR: The space temperature sensor shall have an occupancy override button and occupied mode set point adjustment. The range of set point adjustment shall be limited by the control system to plus or minus 3 (adj.) degrees from 75 (adj.) degrees. The heating set point shall be 4 (adj.) degrees less than the cooling set point. The set points shall be set back to 85 and 65 (adj.) for cooling and heating in unoccupied mode. Pressing the occupancy override button will command the unit into the occupied mode for 1 (adj.) hour.

C. OCCUPANCY MODES:
   1. OCCUPIED: When indexed to the occupied mode, the supply air fan shall be enabled and the fan operational status shall be verified through a current transducer. After the supply air fan status has been proven, the controller shall sequence the cooling or the heating stages to maintain space temperature set point.
      a. Heating Mode – When the space temperature falls below the heating set point, the controller shall sequence the stages of heating to maintain space temperature set point.
      b. Cooling Mode – When the space temperature rises above the cooling set point, the controller shall modulate the chilled water valve to maintain the space temperature set point. When the cool setpoint is reached, the cooling shall be turned off (to avoid humidity buildup in the space due to modulated warm cooling coil discharge air temperatures)
      c. Dehumidification Mode – When the space humidity exceeds 60% the cooling shall be modulated to maintain a supply air temperature of 55 (adj.) degrees if there is a supply air temperature sensor, or just turn on cooling mode if no supply air temperature sensor. Dehumidification mode shall operate until the relative humidity drops below 56%, or after 30 minutes. There shall be a 10 minute time delay before the system can re-enter dehumidification mode.
      d. Outside air damper – If there is an outside air damper actuator, the damper shall be open during occupied mode and closed during unoccupied mode.
   2. UNOCCUPIED: When indexed to the unoccupied mode, the supply air fan shall be disabled and the unit shall be off.
      a. Heating Mode - On a fall below the unoccupied space temperature heating set point, the supply air fan shall be enabled. After the supply air fan status has been proven, controller shall cycle the stages of heating to maintain the unoccupied space temperature set point.
      b. Cooling Mode - On a rise above the unoccupied space temperature cooling set point, the supply air fan shall be enabled. After the supply air fan status has been proven, controller shall modulate the cooling to maintain the unoccupied space temperature set point.

D. OCCUPANCY SENSOR: If present or shown on the control diagrams, the local control system will also monitor the occupancy sensor for the areas served by the fan coil unit and turn the unit to occupied mode when the occupancy sensor is on and unoccupied when the occupancy sensor is off.

E. LIGHTING CONTROLLER: If present or shown on the control diagrams, the local control system will also monitor the lighting for the areas served by the fan coil unit and turn the unit to occupied mode whenever those lights are on and unoccupied whenever the lights are off.

F. REMOTE CONTROL DEVICES: If present or shown on the control diagrams, remote on/off devices, such as door switches, shall modulate the modes from occupied to unoccupied.

3.13 FILTER STATUS PROGRAMMING

A. Provide static pressure sensor across each pre and final filter section which provides a continuous static pressure signal.

B. Coordinate with mechanical and TAB contractor to determine 'clean' filter drop, and 'dirty' filter drop values as listed by the submitted manufacturer. Typically, the pre-filter clean and dirty pressure drops are 0.3" and 0.6" respectively. Typically, the final filter clean and dirty pressure drops are 0.7" and 1.5" respectively.

C. If the static pressure exceeds the dirty filter pressure limit, then provide an alarm which indicates the specific AHU filter is dirty.

D. Indicate current pressure drops and dirty limit on each AHU and FCU graphic page.

E. Provide a separate graphic page on the new, BAS which is dedicated to filters. Provide a table which indicates all filters for all AHUs, the current pressure drop and the dirty pressure drop, as well as a 'dirty filter' indication for all filters sections that exceed the dirty pressure drop. An example of the table is as follows.

Unit Name	***Location***	***Filter Type***	***Pressure Drop Actual***	***Dirty Limit***	***Dirty?***	***Filter Type and Size***	***Quantity***
AHU-1	Mech room 1	Pre	Actual Press Drop	0.6"	Yes/no	By mech contractor	By mech contractor
AHU-1	Mech room 1	Final	Actual press drop	1.5"	Yes/no	By mech contractor	By mech contractor
AHU-2	Mech room 2	Pre	Actual Press drop	0.6"	Yes/no	By mech contractor	By mech contractor

F. For each air handling unit graphical screen provide a button to access a separate graphical screen containing just reheat coils associated with that air handling unit.

3.14 AHU REHEAT COIL PROGRAMMING TABLE

A. Provide a reheat coil table similar to the following for each AHU/RTU with reheat coils:

Reheat Coil	***Serving Room***	***Sensor Set point***	***Space Temp***	***Temp Difference***	***Command Valve Position***	***Actual Valve Position***	***Supply Air Reset Calc***	***Coil Problem?***
1	Clean storage	Input from sensor	Input from sensor	Sensor set point – space temp	45%	46%	ν Yes □ No	Yes/no
2	Corridor	Input from sensor	Input from sensor	Sensor set point – space temp	21%	21%	ν Yes ĺNo	Yes/no
3	Office 23	Input from sensor	Input from sensor	Sensor set point – space temp	10%	10%	□ Yes ν No	Yes/no

B. Provide diagnostic logic in the "Coil Problem" column to identify a problem if a) temp difference is more than 2F for more than 10 minutes, b) or the actual valve position differs from the commanded position by 5% for more than 10 minute Provide diagnostic logic in the "Coil Problem" column to identify a problem if a) temp difference is more than 2F for more than 10 minutes, b) or the actual valve position differs from the commanded position by 5% for more than 10 minutes.

C. Pick boxes shall be in the “Supply Air Reset Calc” column to allow the user to include or exclude a particular reheat coil valve form the reset calculation.

3.15 PACKAGED UNITARY EQUIPMENT CONTROLS

A. In addition to the Basic and General requirements listed in previous paragraphs, provide the following items specific to this type of operation.

B. UNITARY EQUIPMENT: In general, the manufacturer of this equipment provides a basic control system integrated into the equipment. When the specified control logic exceeds what was provided by the manufacturer, the controls contractor shall provide supplemental devices and controls to achieve the controls design intent.

C. SMALL SPLIT-DX. This can be either a cooling only unit or a heat pump with or without supplementary heat. Install the remote thermostat or space sensor and provide necessary installation and integration with BAS.

D. UNIT HEATERS: These can be either electric or hydronic. Install remote thermostats or space sensors, and other ancillary control devices (actuators, etc). Provide a standard interface with the BAS to monitor integral status and operating points.
   1. Heating mode - When the space temperature falls below 60ºF, the controller shall enable the fan. The controller shall sequence the heating coil to maintain space temperature setpoint. When the space temperature rises above 65ºF, the heating coil and fan shall be turned off. For electric heaters, the fan on status shall be proven before the heating element is turned on.
   2. Low Limit Alarm – When the unit heater(s) is in a space with water pipes subject to freezing, the space sensor shall provide an alarm to the BAS when the space temperature falls below a low limit of 40F (adjustable).

END OF SECTION

SECTION 232113

HYDRONIC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:
   1. Hot-water heating piping.
   2. Chilled-water piping.
   3. Makeup-water piping.
   4. Drain and Vent piping.
   5. Safety-valve-inlet and -outlet piping.

B. Related Sections include :
   1. Division 23 Section “Seismic Restraint for HVAC”.
   2. Division 23 Section “Vibration Controls for HVAC”.
   3. Division 23 Section "Hydronic Pumps".
   4. Division 23 Section “Expansion Fittings and Loops for HVAC Piping”.
   5. Division 23 Section “Hydronic Piping Specialties”.
   6. Division 23 Section “General-Duty Valves for Hydronic Piping”.
   7. Division 23 Section “Hangers and Supports for HVAC”.

1.03 DEFINITIONS

A. Design Pressure: Minimum required pressure rating requirement at indicated operating temperature of piping systems and associated valves, fittings, and specialties for sustained operation.

B. Maximum System Design Pressure: Maximum sustained operating pressure during normal operating conditions in associated piping systems, typically downstream of the pump.

C. Working Pressure: Maximum sustained operating pressure during normal operating conditions in associated piping systems, typically downstream of the pump.

D. HDPE: High density polyethylene.

E. PEX: Crosslinked polyethylene.

F. PP-R: Copolymer polypropylene material with random monomers orientation.

G. PP-RCT: Crystalline form of copolymer polypropylene material.

H. SDR: Standard dimension ration where pipe wall thickness is a ratio of the outside dimension.

1.04 PERFORMANCE REQUIREMENTS

A. Products shall be suitable for piping system fluids, materials, pressures, and temperatures.

B. Hydronic piping, components, fittings, specialties and installation shall withstand the following minimum design pressure and temperature:
   1. Copper Tube: 125 psig at 200 deg F.
   2. Schedule 40 steel Pipe: 125 psig at 200 deg F.
   3. Schedule 80 CPVC Plastic Pipe: 125 psig at 130 deg F.
   4. Schedule 40 PVC Plastic Pipe: 120 psig at73 deg F.
   5. Makeup-Water Piping: Equal to the pressure of the piping system to which it is attached.
   6. Drain and Vent Piping: Equal to the pressure of the piping system to which it is attached.

7. Hydronic Fittings, Valves, Meters and Specialties: Equal to the pressure of the piping system to which it is attached.
8. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

C. Hydronic piping, components, fittings, specialties and installation shall withstand pressures required by pressure test requirements of these specifications. Pressure test of hot systems to be performed at reduced temperature.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of the following, provide product data for all items including as applicable dimensions, capacities, materials of construction, non-compatible fluids, pressure and temperature ratings, pressure drop and appropriate identification:
1. Pipe and fittings.
2. Plastic pipe and fittings with solvent cement.
3. Plastic pipe and fittings with fusion weld.

B. Shop Drawings:
1. Detail, at 1/8” scale, coordinated piping drawings.
2. Include details for fabrication of hangers, supports for multiple pipes, pipe anchors and guides, expansion joints, pipe bends and loops, and attachments of the same to the building structure.
3. Detail location of anchors, alignment guides, and expansion joints and loops.
4. For preinsulated piping systems, the supplier shall provide the 1/8” coordinated piping drawings. Include for underground piping trenching requirements, pipe insulation, fitting insulation and means to control and accommodate thermal piping expansion.

C. Delegated-Design Submittal:
1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion fittings and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion fittings and loops.

1.06 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Grooved joint products shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series number.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.08 QUALITY ASSURANCE

A. Hydronic piping, specialties and components shall be fabricated and installed to comply with ASME and ASTM Standards.

B. Installer Qualifications:
1. Installers of Press fitting Joints: Installers shall be certified by the press fitting manufacturer as having been trained and qualified to join piping with press fittings.
2. Polypropylene and HDPE Pipe and Fittings Installers: Installers of polypropylene and HDPE piping shall have current certification by manufacturer of pipes and fittings as having been

trained and qualified to join polypropylene and HDPE piping using fusion welding equipment as supplied or approved by the manufacturer (socket, butt, electrofusion, fusion outlet).

C. All plastic pipe, joint couplings, fittings and valves shall be of the same manufacturer when available.

D. Steel Support Welding: Qualify procedures and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

E. Pipe Welding: Qualify procedures and operators according to ASME standards including Boiler and Pressure Vessel Code: Section IX.
   1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

F. Fusion Welding: Qualify procedures and operators according to manufacturer's requirements and requirements of the International Ground Source Heat Pump Association.

PART 2 - PRODUCTS

2.01 GENERAL

A. Hydronic piping, components, fittings, specialties and installation shall be suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 "Performance Requirements" Article.

B. Hydronic piping, components, fittings, specialties and installation shall withstand 1.5 times the system's working pressure for pressure test requirements. Refer to expansion tank schedule for project specific working pressure.

2.02 COPPER TUBE AND FITTINGS

A. Drawn-Temper (hard) Copper Tubing: ASTM B 88, Type L.

B. Copper and Copper Alloy Fittings: Soldered or brazed joints.

2.03 STEEL PIPE AND FITTINGS

A. Steel Pipe – 2" and smaller: ASTM A 53/A 53M, black steel with plain ends; Grade B, type E electric resistance welded, or Grade A, type F continuously welded, schedule 40.

B. Steel Pipe – 2 ½" and larger: ASTM A 53/A 53M, black steel with plain ends; Grade B, type E electric resistance welded, schedule 40.

C. Cast-Iron Threaded Fittings: Classes 125, 250 or higher as required by Part 1 "Performance Requirements" Article.

D. Malleable and ductile Iron Threaded Fittings: Classes 150, 300 or higher as required by Part 1 "Performance Requirements" Article.

E. Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

F. Forged-Steel Flanges and Flanged Fittings: Classes 125, 150 or higher as required by Part 1 "Performance Requirements" article including bolts, nuts, and gaskets.

G. Stainless Steel Pipe and fittings: ASTM A 312/A 312M type 316L stainless steel pipe, type S seamless, schedule 40 with flanged or welded fittings.
   1. At the Contractor's option in lieu of threaded steel or soldered copper in applicable piping systems NPS 2 (50mm) and smaller, ASTM A312, Schedule 10S, Type 304/304L stainless steel pipe with plain ends and Vic-Press fittings and couplings may be used.
      a. Fittings: Precision, cold drawn, stainless steel with elastomer O-ring seals.
      b. System suitable for working pressure to 500-psig (3450-kPa)

2.04 PLASTIC PIPE AND FITTINGS

A. Plastic pipe: Label each pipe section to indicate nominal size, wall thickness, pressure and temperature ratings and type of material.

B. CPVC Plastic Pipe: ASTM F 441/F 441M, Schedules 80, plain ends.

C. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 439 for Schedule 80 pipe.

D. PVC Plastic Pipe: ASTM D 1785, Schedules 40, plain ends.

E. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe.

2.05 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Nonmetallic, flat, asbestos-free, suitable for chemical, thermal and pressure conditions of piping system contents and piping components being joined.

B. Flange Bolts and Nuts: Carbon steel, unless high strength steel is required for high temperatures and pressure..

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; or BAg1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493. Include primer according to manufacturer's requirements.
   2. PVC Piping: ASTM D 2564. Include primer according to manufacturer's requirements.

2.06 TRANSITION FITTINGS

A. Transition fittings for plastic to metallic piping systems shall be provided by the plastic piping manufacturer.

B. Unions: Assembly of steel, copper, copper alloy or plastic to match associated piping systems with neoprene gasket and with threaded, solder-joint, plain, grooved or weld-neck end connections that match piping system materials.

C. Plastic-to-Metal Transition, Flanged: Flange fitting of plastic material equal to the piping system with compatible plastic pipe connection with encapsulated steel backing ring, flange and gasket to be attached to same size flange of any other piping material with matching hole pattern and flange sizes.

D. Plastic-to Metal Transition, Adapter: Plastic and copper alloy materials with gasket and with compatible plastic pipe connection and threaded end connections that match piping system materials.

2.07 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with insulating material and with threaded, solder-joint, plain, grooved, fusion weld or weld-neck end connections that match piping system materials

B. Dielectric Unions: Factory-fabricated, union assembly with neoprene gasket.

C. Dielectric Flanges: Factory-fabricated, companion-flange assembly including bolts, nuts, and gaskets.

PART 3 - EXECUTION

3.01 PIPING SCHEDULES

A. Hydronic piping, components, fittings, specialties and installation shall suitable for indicated service with design pressure and temperature ratings as indicated in Part 1 “Performance Requirements” Article.

B. Fittings, specialties and valves to be compatible with associated piping systems utilizing soldered, brazed, press fittings, grooved, screwed, welded, flanged, solvent cement or fusion welded fittings as indicated in Part 2 specifications.

C. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Copper tubing (hard), copper and copper alloy fittings.
   2. Steel pipe; Steel, ductile or malleable iron fittings.

D. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Steel pipe, steel fittings.

E. Chilled-water piping in non-corrosive environments, aboveground, NPS 2 and smaller, shall be any of the following:
   1. Copper tubing (hard), copper and copper alloy fittings.
   2. Steel pipe; Steel, ductile or malleable iron fittings.
   3. PVC plastic pipe and fittings. PVC is not acceptable for glycol concentrations of 25% or more. Not to be used in return air plenums.

F. Chilled-water piping in non-corrosive environments, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. Steel pipe, Steel, ductile or malleable iron fittings.
   2. PVC plastic pipe and fittings. PVC is not acceptable for glycol concentrations of 25% or more. Not to be used in return air plenums.

G. Chilled-water piping in corrosive environments, aboveground, NPS 2 and smaller, shall be any of the following:
   1. PVC plastic pipe and fittings. PVC is not acceptable for glycol concentrations of 25% or more. Not to be used in return air plenums
   2. Stainless steel pipe and fittings.

H. Chilled-water piping in corrosive environments, aboveground, NPS 2-1/2 and larger, shall be any of the following:
   1. PVC plastic pipe and fittings. PVC is not acceptable for glycol concentrations of 25% or more.
   2. Stainless steel pipe and fittings.

I. Makeup-water piping shall be either of the following:
   1. Copper tubing (hard), copper and copper alloy fittings.
   2. Steel pipe: steel, ductile or malleable iron fittings.
   3. CPVC plastic pipe and fittings.

J. Condensate-Drain Piping shall be any of the following:
   1. Copper tubing (hard), copper and copper alloy fittings.
   2. PVC plastic pipe and fittings.

K. Specialties, Drain and Vent Piping: Same materials and joining methods as for piping specified for the service in which it is installed.

L. Transition Fittings: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

M. Safety Relief Valve and Pressure Relief Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which relief valve is installed.
   1. Provide a relief valve in each closed loop system.

3.02 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel or groove plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Plastic piping joints to be made in accordance with the piping and fitting manufacturer's instructions.

D. Copper Pipe Joints:
   1. 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.
   2. 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.
   3. Press fitting Joints: In accord with manufacturer's installation instructions. Tubing shall be full inserted into fitting and marked. The fitting alignment checked against the mark to assure the tubing is fully engaged. The joints shall be sealed by pressing tools approved by the manufacturer.
   4. Grooved Mechanical Joint: In accord with manufacturer's installation instructions. Roll groove in pipe. Apply joint lubricant to gasket and pipe ends as dictated by manufacturer's installation instructions. Install gasket, align pipe ends and gasket, and secure fitting housing.

E. Steel Pipe Joints
   1. Threaded Joints: Thread pipe with tapered pipe threads according to ASME. 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:
      a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
      b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
   2. Welded Joints: Weld steel joints according ASME code, ANSI and State codes as applicable, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
   3. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
   4. Grooved Mechanical Joint: In accord with manufacturer's installation instructions. Cut or roll groove in pipe and remove all cutting residue. Apply joint lubricant to gasket and pipe ends. Install gasket, align pipe ends and gasket, and secure fitting housing.

F. Plastic Piping Solvent-Cement Joints: Prepare, clean and dry joining surfaces according to manufacturer's instructions. Join pipe and fittings according to the following:
   1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
   3. PVC Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

3.03 PIPING INSTALLATIONS

A. Refer to other Division 23 specifications including Common Work Results for HVAC for additional requirements.

B. Install piping to allow for thermal expansion using offsets, loops, swing joints, expansion joints, vibration isolation and anchors as necessary to limit stress. Connect risers, branches and run outs to terminal equipment to main or branch lines with at least three pipe fittings, including tee in main or branch.

C. During construction, provide temporary end caps on all piping to prevent dirt and debris from entering the piping system.

D. Use only long radius elbows having a center line radius of 1.5 pipe diameters for welded or flanged systems. In Victaulic installations, standard “as-cast full-flow” fittings shall be used.

E. "Weld-o-lets” and “Thread-o-lets” may be used for branch takeoffs up to one-half (1/2) the diameter of the main.

F. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with chained cap, at low points in piping system mains and elsewhere as required for complete system drainage.

G. Install all valves, control valves and piping specialties including items furnished by others as specified and/or detailed. Make connections to all equipment installed by others where that equipment requires the piping service indicated in this section.

H. Install dielectric fittings in piping systems where indicated and at connections of dissimilar metals: including but not limited to steel to copper connections. Install unions or flexible hose connectors with unions for piping NPS 2 (DN 50) and smaller. Install flanges for piping NPS 2-1/2 (DN 65) and larger.

I. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated. Identify on exterior of insulated cold piping systems locations of unions. Unions are to be installed on the equipment side of shut-off valves.

J. Flexible hose connectors with unions may be applied for piping NPS 2 (DN 50) and smaller for connections to equipment and to facilitate flushing of piping systems. Coordinate application with vibration isolation specifications. Flexible hose connectors are to be installed on the equipment side of shut-off valves.

K. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

L. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points if required.)

M. All materials (e.g. firestopping, insulation mastic, cutting oils, etc.) that are used not only as part of the mechanical system with the CPVC piping, but all products from any other trade that may come in contact with the CPVC piping, shall be listed as approved on the Lubrizol CPVC compatibility charts and by the piping manufacturer. Contractor shall ensure no low voltage cabling is in contact with any CPVC piping

N. Install branch connections to mains with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

O. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

P. Route condensate piping to nearest approved sanitary or storm drain per requirements of authority having jurisdiction. For rooftop units, route condensate piping from unit drain trap to nearest approved drain. Elevate piping and secure to roof per code requirements.

Q. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

R. The following spaces shall be considered Corrosive Environments:
   1. Exterior spaces within 10 miles of the coast.
   2.] Exterior at Salt Water Theme Parks or Exhibits.

3.04 CHEMICAL TREATMENT

A. Install chemical treatment piping as indicated on the drawings, as detailed, as specified, and as recommended by the supplier of the chemical treatment equipment.

B. When expanding existing systems, coordinate with facility's existing chemical treatment program to establish an existing chemical balance of the piping system prior to connecting new work. Upon completion of the new piping installation, return the chemical balance to the recommended chemical levels.

3.05 PRE-INSULATED PIPE

A. Install underground piping in compliance with manufacturers recommended procedures and details. Pitch all pipe one inch in forty feet toward all drain points.

B. Steel Piping:
   1. Provide schedule 40 black steel, pre-insulated building entry elbows with steel thrust plates attached to carrier pipe, and FRP coated for a complete water proof casing. Pre-fab elbows will include compression type rubber end seals on both ends. If PVC pipe is used in the yard, the carrier I.D. will be the same as the steel pipe O.D. in order to slide PVC bell over entry elbow end providing complete thermal movement protection.

3.06 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC."

B. Mounting and anchoring requirements for seismic installations are specified in Division 23 Section "Seismic Restraint for HVAC."

3.07 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections and associated specialties shall be the larger of that indicated on the plans or the associated equipment connection. Branch transitions, when requried, shall be located at the point of connection to the equipment.

B. Install control valves and strainers in accessible locations close to connected equipment.

C. Provide temporary bypass piping around terminal equipment including, coils, heat exchangers, chillers and boilers to allow for flushing and cleaning of piping systems. Flexible hose connectors if included in Hydronic Piping Specialties specifications may be applied to use as bypass piping.

3.08 FIELD QUALITY CONTROL

A. Prepare hydronic piping for hydrostatic pressure test according to ASME and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush and clean hydronic piping systems with clean water; then remove and clean or replace strainer screens. Refer to Common Work Results for HVAC for additional requirements.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve.

5. Install temporary pressure relief valves, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following piping system hydrostatic leak tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
   3. Isolate expansion tanks and make up water and determine that hydronic system is full of water.
   4. Subject piping system to hydrostatic test pressure at low elevation point of the system that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stresses do not exceed values in ASME. Hydrostatic test piping systems at the higher value of 100 psig or 1.5 times the system's working pressure.
      a. Note: Some manufacturers of various system components such as press fittings require a lower pressure test. Should the contractor install any system components that the manufacturer specifically requires a lower pressure test, this shall be completed prior to that indicated here. The manufacturers testing requirements shall be adhered to.
   5. Measure and record test pressure at the low point in the system.
   6. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
   7. Reduce system pressure back to system fill pressure and reconnect expansion tank and make up water.
   8. Prepare written report of testing.

C. Perform the following before operating the system:
   1. Open manual valves fully.
   2. Inspect pumps for proper rotation.
   3. Verify make up water pressure reducing valve is set for required system pressure.
   4. Install pressure relief valve set for required system pressure.
   5. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
   6. Set temperature controls so all coils are calling for full flow.
   7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
   8. Verify lubrication of motors and bearings.

END OF SECTION

SECTION 232300

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes refrigerant piping and installation for air-conditioning applications.

B. This section includes the field installation of compressors, condensers, coils, condensing units, and all other fittings, devices, and accessories required to complete the refrigeration systems as shown on the drawings.

C. For detailed installation instructions, refer to the manufacturer's installation manuals. The contractor shall provide all necessary piping, refrigerant, and accessories required for a complete operating system.

D. This contractor is responsible for unloading, assembling, and installing all equipment and specialties.

1.03 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a:
   1. Suction Lines for Air-Conditioning Applications: 115 psig.
   2. Suction Lines for Heat-Pump Applications: 225 psig.
   3. Hot-Gas and Liquid Lines: 225 psig.

B. Line Test Pressure for Refrigerant R-402B, R-404A, R-507,R-407C:
   1. Suction Lines for Air-Conditioning Applications: 230 psig.
   2. Suction Lines for Heat-Pump Applications: 380 psig.
   3. Hot-Gas and Liquid Lines: 380 psig.

C. Line Test Pressure for Refrigerant R-410A:
   1. Suction Lines for Air-Conditioning Applications: 300 psig.
   2. Suction Lines for Heat-Pump Applications: 535 psig.
   3. Hot-Gas and Liquid Lines: 535 psig.

1.04 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
   1. Thermostatic expansion valves.
   2. Solenoid valves.
   3. Hot-gas bypass valves.
   4. Filter dryers.
   5. Strainers.
   6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
   1. Shop Drawing Scale: 1/4 inch equals 1 foot.
   2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to

accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.05 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.06 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.07 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.50.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8 Class BCuP-5

E. Flexible Connectors:
1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.02 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:
1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
3. Operator: Rising stem and hand wheel.
4. Seat: Nylon.
5. End Connections: Socket, union, or flanged.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:
   1. Body and Bonnet: Forged brass or cast bronze.
   2. Packing: Molded stem, back seating, and replaceable under pressure.
   3. Operator: Rising stem.
   4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
   5. Seal Cap: Forged-brass or valox hex cap.
   6. End Connections: Socket, union, threaded, or flanged.
   7. Working Pressure Rating: 500 psig.
   8. Maximum Operating Temperature: 275 deg F.

C. Service Valves (Shrader Valve):
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Copper spring.
   5. Working Pressure Rating: 500 psig.

D. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
   1. Body and Bonnet: Plated steel.
   2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
   6. Working Pressure Rating: 400 psig.
   7. Maximum Operating Temperature: 240 deg F.

E. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
   2. Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Seat Disc: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Working Pressure Rating: 400 psig.
   6. Maximum Operating Temperature: 240 deg F.

F. Thermostatic Expansion Valves: Comply with ARI 750.
   1. Body, Bonnet, and Seal Cap: Forged brass or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
   5. Suction Temperature: 40 deg F.
   6. Balanced Port design
   7. Externally equalized
   8. Superheat: Adjustable.
   9. Reverse-flow option (for heat-pump applications).
   10. End Connections: Socket, flare, or threaded union.
   11. Working Pressure Rating: 700 psig.

G. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
   1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
   2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
   3. Packing and Gaskets: Non-asbestos.
   4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   5. Seat: Polytetrafluoroethylene.

6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and 24-V ac coil.
7. End Connections: Socket.
8. Set Pressure: Adjustable
9. Throttling Range: Maximum 5 psig.
10. Working Pressure Rating: 500 psig.
11. Maximum Operating Temperature: 240 deg F.

H. Evaporator Pressure Regulators
1. Maximum rated pressure 450 psig
2. Adjustable settings up to 150 psig
3. Normally open design
4. High side pilot operation

I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

K. Moisture/Liquid Indicators:
1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig.
7. Maximum Operating Temperature: 240 deg F.

L. Replaceable-Core Filter Dryers: Comply with ARI 710.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: Solid core molecular sieve style
3. Desiccant Media: Activated alumina.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: Based upon equipment capacity
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

M. Permanent Filter Dryers: Comply with ARI 710.
1. Body and Cover: Painted-steel shell.
2. Filter Media: Solid core molecular sieve style.
3. Desiccant Media: Activated alumina.

4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig.
8. Rated Flow: Based upon equipment capacity
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

N. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

O. Receivers: Comply with ARI 495.
1. Comply with UL 207; listed and labeled by an NRTL.
2. Body: Welded steel with corrosion-resistant coating.
3. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
4. End Connections: Socket or threaded.
5. Working Pressure Rating: 500 psig.
6. Maximum Operating Temperature: 275 deg F.

P. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig.
4. Maximum Operating Temperature: 275 deg F.

2.03 REFRIGERANTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

B. ASHRAE 34, R-134a: Tetrafluoroethane.

C. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.

D. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS FOR REFRIGERANTS

A. Lines NPS 3/4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Lines NPS 1/2 to NPS 4 for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.02 VALVE AND SPECIALTY APPLICATIONS

A. Provide isolating, charging, purging check, and relief valves to allow for control, isolation, charging, excessive pressure protection and pressure monitoring of all field modified refrigeration equipment.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

D. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

E. Install thermostatic expansion valves as close as possible to distributors on evaporators.
   1. Install valve so diaphragm case is warmer than bulb.
   2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
   3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

F. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

G. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

H. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
   1. Solenoid valves.
   2. Thermostatic expansion valves.

I. Install filter dryers in liquid line between compressor and thermostatic expansion valve [and in the suction line at the compressor. Install low pressure drop felt cores in suction line filter shell]

J. Install receivers sized to accommodate pump-down charge.

K. Install flexible connectors at compressors.

3.03 SPLIT-DX SYSTEMS

A. Install refrigerant piping and accessories as recommended by the manufacturer and this specification.

3.04 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Nitrogen must be flowed through the inside of the piping system during any brazing operations. The piping system shall be left open at one point to prevent the nitrogen from building up any pressure inside the pipe. The nitrogen must flow into and out of the piping system during brazing to displace any oxygen inside the pipe.

C. Install refrigerant piping according to ASHRAE 15.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Install piping adjacent to machines to allow service and maintenance.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Manufactured brazed ASME 16.50 fittings shall be used. Field fabricated mitered elbows and tees will not be allowed.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation" for solenoid valve controllers, control wiring, and sequence of operation.

M. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

N. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

O. Install refrigerant piping in protective conduit where installed belowground. Soft copper only is to be used with no joints in the underground portion.

P. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

Q. Slope refrigerant piping as follows:
   1. Piping slope shall be 2-1/2” per 20 feet to prevent oil trapping.
   2. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   3. Install horizontal suction lines with a uniform slope downward to compressor.
   4. Install traps and double risers to entrain oil in vertical runs.
   5. Liquid lines may be installed level.

R. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

S. Install pipe sleeves at penetrations in exterior walls and floor assemblies.

T. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

U. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

V. Install sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.

W. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

X. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

3.05 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
   1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
   2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

D. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.06 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs.
   2. Trapeze strut hangers with vibration inserts for multiple horizontal piping
   3. Copper-clad hangers and supports for hangers and supports with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
   4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
   7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
   8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
   1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   3. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   4. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.

E. Support multifloor vertical runs at least at each floor.

3.07 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. The Contractor shall notify the Architect in advance of any test so that Owner’s representatives may be present for tests if desired.

C. Tests and Inspections:
   1. Comply with ASME B31.5, Chapter VI.
   2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
   3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

a. Fill system with nitrogen to the required test pressure.
b. System shall maintain test pressure at the manifold gage throughout duration of test.
c. Test joints and fittings with electronic leak detector and by brushing a small amount of soap and glycerin solution over joints.
d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.08 SYSTEM CHARGING

A. Charge system using the following procedures:
1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 250 micrometers. Turn off vacuum pump and isolate system. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.

3.09 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

3.10 OPERATION AND CHECK-OUT

A. Contractor shall be responsible for the proper adjustment of all refrigeration controls in the system, including controls on each refrigeration circuit, air temperature controls in the machine room, remote condenser controls, water regulation valves, or other related controls.

B. The contractor shall check the compressor overload protectors with the manufacturer’s specifications, and inform the Architect if they are incorrect.

C. The contractor shall check and make any adjustments to the controls during the first 4 hours of system operation. The contractor’s refrigeration mechanic shall remain on site all day during the first day of full operation of each system.

D. Include Operation and Check-out report with close-out documents.

END OF SECTION

SECTION 233005

COORDINATION DRAWINGS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the requirement for all trades to coordinate their work in the available space and to reflect this effort on a composite drawing.

1.02 SUBMITTALS

A. Shop Drawings: Upon completion of the metal ductwork shop drawings, the sheetmetal subcontractor shall prepare a complete set of CAD generated background drawings at a scale not less than 3/8" equals 1'-0", showing structure, owner furnished equipment, etc., and other information as needed for coordination. He shall show sheetmetal layout thereon. These will become the basis for the Coordination Drawings. Other software specifically designed for construction coordination may be acceptable.

B. Plots of the coordination drawings shall be distributed sequentially to each specialty trade. Each of the below specialty trades shall add its work to these background drawings with appropriate elevations and grid dimensions. Specialty trade information is required for mechanical rooms, horizontal exits from duct shafts, crossovers, and for spaces in and above ceilings where congestion of work may occur such as corridors, and even entire floors. Drawings shall indicate horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions, and other services. Specialty trades include but are not limited to Plumbing, HVAC Piping, Electrical, Ductwork, and Fire Protection.
   1. Coordination Drawings include but are not necessarily limited to new and existing for:
      a. Structure
      b. Equipment
      c. Ride Equipment
      d. Partition/room layout
      e. Ceiling tile and grid
      f. Light fixtures
      g. Access panels
      h. Sheet metal, heating coils, boxes, grilles, diffusers, etc.
      i. All piping and valves
      j. Smoke and fire dampers
      k. Soil, waste and vent piping
      l. Domestic water, sanitary, and storm piping
      m. Specialty gas piping
      n. Major electrical conduit runs, panelboards, feeder conduit and racks of branch conduit
      o. Above ceiling miscellaneous metal
      p. Sprinkler piping and heads
   2. All firewalls and smoke partitions must be highlighted on the coordination drawings for appropriate coordination.
   3. The main paths of egress and for equipment removal, from main mechanical and electrical rooms must be clearly shown on the coordination drawings.
   4. Illustrate clear maintenance access, coil pull, and code required clearance for all equipment.
   5. Illustrate code minimum required clearances between miscellaneous vents, exhaust air outlets and outdoor air intakes.
   6. Coordinate final location of floor drains with housekeeping pads and equipment locations.

C. Each specialty trade shall sign and date each coordination drawing. Return drawings to the Sheetmetal Subcontractor, who shall route them sequentially to all specialty trades.

D. Where conflicts occur with placement of materials of various trades, the Sheetmetal Subcontractor will be responsible to coordinate the available space to accommodate all trades. Any resulting adjustments shall be initialed and dated by the specialty trade. The Sheetmetal Subcontractor shall then final date and sign each drawing. If he cannot resolve conflicts, the decision of the General Contractor shall be final.

E. A Subcontractor who fails to promptly review and incorporate his work on the drawings shall assume full responsibility of any installation conflicts affecting his work and of any schedule ramifications.

F. Fabrication of any MEP/FP systems shall not start the coordination drawings have been submitted. The Coordination Drawings are for A/E review only and for requesting A/E assistance with irresolvable areas of conflict. A completed review of the coordination drawings by the A/E is not required to commence installation.

G. Review of coordination drawings shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with Architectural, Structural, Mechanical, Electrical and other work.

H. Any changes after the completion of the coordination drawing review process shall be approved in writing by the A/E prior to start of work in affected areas.

PART 2 - PRODUCTS

2.01 Not used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 233113

METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Single-wall rectangular ducts and fittings.
   2. Double-wall rectangular ducts and fittings.
   3. Single-wall round and flat-oval ducts and fittings.
   4. Double-wall round and flat-oval ducts and fittings.
   5. Sheet metal materials.
   6. Duct liner.
   7. Sealants and gaskets.
   8. Hangers and supports.

B. Related Sections include:
   1. Division 23 Section “Hangers and Support for HVAC” for hangers and supports.
   2. Division 23 Section “Vibration Controls for HVAC Piping and Equipment” for vibration isolation.
   3. Division 23 Section “HVAC Insulation” for ductwork external insulation.
   4. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
   5. Division 23 Section "Seismic Restraint For HVAC Piping and Equipment" for requirements necessary for compliance with seismic criteria.

1.03 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, fittings and hangers and supports to comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and requirements of Part 3Articles.

B. Structural Performance: Design duct hangers and supports and seismic restraints to withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems" and ASCE 7-05 as Delegated Design.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. All system products provided for this project shall conform to NFPA Section 90A and possess a flame spread rating of not over 25 and a smoke developed rating no higher than 50.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of the following products:
   1. Double-Wall manufactured ductwork
   2. Liners and adhesives.
   3. Sealants and gaskets.

B. Shop Drawings: Completely coordinated with all other trades and include:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.

3. Double line duct layout drawings indicating sizes, configuration, liner material, and static-pressure classes.
4. Duct elevation.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including all dampers (manual, control, fire/smoke), turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Unresolved conflicts between trades shall be clearly noted.

D. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports and, as applicable, seismic restraints.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, piping and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to 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 D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Comply with applicable SMACNA Standards.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6.4.4 - "HVAC System Construction and Insulation."

E. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 - PRODUCTS

2.01 GENERAL

A. All manufactured ductwork and fittings shall be manufactured by a company whose primary business is single wall and double wall spiral duct and fittings and double wall rectangular duct and fittings who has been in business for ten (10) years, minimum.

2.02 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA Standards.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA.

D. Fittings: Select according to requirements of the drawings and specifications of similar construction to match duct system.

2.03 DOUBLE-WALL MANUFACTURED RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Lindab Inc.
   2. McGill AirFlow LLC.
   3. SEMCO Incorporated.
   4. Lewis & Lambert

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", based on static-pressure class unless otherwise indicated.
   1. Transverse Joints: Select joint types and fabricate according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA Standards.
      a. Construct for duct connector slip or flange fittings to maintain the annular space between the inner and outer ducts and to provide end seals for the insulation.
      b. Transverse Joints in Ducts Larger Than 40 Inches: Flanged.
   2. Longitudinal Seams: Select seam types and fabricate according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA Standards.
   3. Fittings: Select fittings according to requirements of the drawings and specifications of similar construction to match duct system.

D. Inner Duct: Minimum 0.028-inch (24 gage .7-mm) perforated having 3/32-inch-diameter perforations, with overall open area of 23 percent galvanized sheet steel.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Thickness shall be 2".
4. Coat insulation with antimicrobial coating.
5. If perforated inner duct is used, cover insulation with polyester film complying with UL 181, Class 1

2.04 SINGLE-WALL MANUFACTURED ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Lindab Inc.
2. McGill AirFlow LLC
3. SEMCO Incorporated
4. Lewis & Lambert
5. Crown

B. Duct shall be machine formed round and/or flat oval spiral lock seam duct or longitudinal seam duct constructed of galvanized steel as specified suitable for pressure class specified. Use manufactured duct and fittings as indicated on the drawings and as required in accordance with manufacturer's published data.

C. The use of lighter gauge single rib ductwork is not allowed.

D. The use of snap lock ductwork is not allowed. The use of adjustable segmented elbows is not allowed.

E. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," based on indicated static-pressure class unless otherwise indicated.

F. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

G. Transverse Joints: Select slip or flange joint types and fabricate according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA Standards.
1. Transverse Joints in round ducts larger than 30 Inches in Diameter: Flanged.
2. Transverse joints in flat oval ducts larger than 24" minor or 42" major dimension: Flanged.
3. Transverse joints in round ducts up to 20 inches in diameter: O-ring Seals.

H. Spiral Seams: Utilize spiral lock seams fabricated according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materals involved, duct support intervals and other provisions in SMACNA Standards.

I. Fittings: Select according to requirements of the drawings and specifications of similar construction to match duct system.

2.05 DOUBLE-WALL MANUFACTURED ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Lewis & Lambert
5. Crown

B. Duct shall be machine formed round and/or flat oval spiral lock seam duct or longitudinal seam duct constructed of galvanized steel as specified suitable for pressure class specified. Use manufactured duct and fittings as indicated on the drawings and as required in accordance with manufacturer's published data.

C. The use of lighter gauge single rib ductwork is not allowed.

D. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

E. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
   1. Transverse Joints: Select joint types and fabricate according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, duct reinforcement and other provisions in SMACNA Standards.
      a. Construct for duct connector slip or flange fittings to maintain the annular space between the inner and outer ducts and to provide end seals for the insulation.
      b. Transverse Joints in round ducts larger than 30 Inches in Diameter: Flanged.
      c. Transverse joints in flat oval ducts larger than 24" minor or 42" major dimension: Flanged.
   2. Spiral Seams: Utilize spiral lock seams fabricated according to SMACNA Standards suitable for static-pressure class, applicable sealing requirements, materials involved, duct support intervals and other provisions in SMACNA Standards.
   3. Fittings: Select according to requirements of the drawings and specifications of similar construction to match duct systems.

F. Inner Duct: Minimum 0.028-inch perforated having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent galvanized sheet steel.

G. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
   3. Thickness shall be 2 inches.
   4. Coat insulation with antimicrobial coating.
   5. If perforated inner duct is used, cover insulation with polyester film complying with UL 181, Class 1.

2.06 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   1. Galvanized Coating Designation: G90.
   2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on opposite surface.
   3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

H. Tie Rods: Galvanized steel, all thread rod, tubing or conduit sized per SMACNA Standards.

2.07 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   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. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
   2. Maximum Thermal Conductivity:
      a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
   3. For interior applications, liner thickness shall be 1 inch. For exterior applications, liner thickness shall be 2 inches.
   4. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial, fungicidal coating shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems. Coating shall meet ASTM D 5590 with 0 growth rating. Coating shall be Foster Products 40-20 or approved equal.
   5. Liner to be suitable for rectangular ducts with air velocities up to 4000 fpm.and temperature to 250 deg F.
   6. Solvent or Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916, Type II.

B. Insulation Pins and Washers:
   1. 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.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" And manufacturer's instructions.
   1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.
   4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   a. Fan discharges.
   b. Intervals of lined duct preceding unlined duct.
   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.08 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 70 percent by volume.
   3. Shore A Hardness: Minimum 20.
   4. Water resistant.
   5. Non-Fibrated.
   6. Mold and mildew resistant.
   7. VOC: Maximum 75 g/L (less water).
   8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
   9. Service: Indoor or outdoor.
   10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   1. General: Single-component, acid-curing, silicone, elastomeric.
   2. Type: S.
   3. Grade: NS.
   4. Class: 25.
   5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.09 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

B. Hanger Rods for Corrosive Environments: Use stainless-steel or fiberglass hangers and supports for corrosive service. Use square nuts made of vinyl ester or hex nuts made of polyurethane or stainless steel.
   1. Use vinyl ester resin fiberglass for “ozone” applications.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
   1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
   2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
   3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

I. Building Attachment: Galvanized steel or equal corrosion resistant metal suitable for attachment to structure: concrete inserts, beam clamps, concrete anchors and welded studs. Powder-actuated fasteners may be applied if allowed by seismic constraints.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION

A. Install ducts, hangers and supports according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless the Contract Documents include more stringent requirements.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Utilize elbows, branch connections and other fittings of the type as shown on the drawings and as specified. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

C. Comply with mounting and anchoring requirements for seismic installations.

D. All duct sizes indicated are clear inside dimensions.

E. Install round and flat-oval ducts in maximum practical lengths.

F. Install ducts with fewest possible joints.

G. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

H. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

I. Install ducts close to walls, columns, and other structural and permanent enclosure elements of building.

J. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness. Maintain a clearance of 6 inches, for rated walls

K. Install ducts as close as possible to underside of beams and joists.

L. Route ducts to avoid passing through electrical rooms and technology rooms.

M. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

N. Install all control dampers, fire dampers, smoke dampers and fire smoke dampers. Comply with requirements in Division 23 Section "Air Duct Accessories".

O. Use splitter dampers and/or extractors only where manual dampers will not accomplish the intended balancing. The use of splitter dampers and/or extractors will not eliminate the need for specified or indicated manual volume dampers.

P. Construct branch take off from duct main with a 45 degree entry fitting or conical fitting. Square edge 90 degree take off fittings, including spin in connections, will not be acceptable.

Q. Use elbows and tees with a center line radius to width or diameter ratio of 1.5 wherever space permits. When a shorter radius elbow is required, provide short radius elbow with full length splitter vanes or mitered elbow with turning vanes.

R. Rectangular Duct – Elbow and Tee Configuration: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Radius with minimum 1.5 radius-to-diameter ratio.
   2. Short radius with full length splitter vanes Type RE 3
   3. Mitered with single wall turning vanes Type RE2 .

S. Round and flat oval Duct – Elbow and Tee Configuration: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Radius type with minimum 1.5 radius-to-diameter ratio.
   2. Mitered type by duct manufacturer with single wall turning vanes.
   3. Adjustable segmented type elbows up to 16 inch may be used for run out ducts to air inlets and outlets.
   4. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.

T. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: 5 piece gored Welded.

U. When specified in part 2, snap lock ductwork is allowed for run out ducts to air inlets and outlets up to 16 inches. The use of adjustable segmented elbows is allowed for run out ducts to air inlets and outlets up to 16 inches. All longitudinal and transverse seams shall be sealed with duct sealant and additionally secured with sheet metal screws. Snap lock construction will not be accepted on aluminum ductwork.

V. Utilize external reinforcements, tie rods and hangers unless size of duct requires internal tie rods.

W. All duct hanger straps are required to be screwed to rectangular duct.

X. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines" exceeding SMACNA’s advanced level of cleanliness.

Y. Where two different metal ducts meet, the joint shall be installed to prevent metal to metal contact by using proper seal or compound.

Z. Outside air intake ducts shall pitch to intakes and drain to outside of building. Provide water tight joints and seams. Blank off all unused portions of louvers with 2 inch board insulation with galvanized sheet metal backing on both sides.

AA. All return air openings above ceilings shall be provided with a ½” mesh aluminum screen.

BB. For exterior ductwork, pitch top of duct to prevent water from pooling on top of duct.

CC. Provide negative pressure relief fittings downstream of all closer devices and as shown on the plans and/or details (i.e., control fire, combination fire/smoke dampers, etc.).

DD. Provide duct accessories included access doors, manual dampers, control dampers, flexible ductwork, flexible connectors, relief doors per Division 23 Section “Air Duct Accessories”.

EE. The following spaces shall be considered Corrosive Environments:
1. Exterior spaces within 10 miles of the ocean or salt water.
2. Exterior at Salt Water Theme Parks or Exhibits,

3.02 ADDITIONAL INSTALLATION REQUIREMENTS OF MANUFACTURED DUCTWORK

A. Construct duct and fittings with reinforcements in accord with the manufacturer’s published data and SMACNA. Remove internal shipping braces if provided.

B. Utilize external reinforcements for double wall duct systems.

C. Utilize manufacturer’s slip type or flanged connectors to connect duct. Use with double wall duct sections to maintain annular space and seal insulation from the air stream. Connectors shall fit tight to the inner duct wall without projecting into the duct air stream.

D. All takesoffs or branch connections shall be provided by the duct manufacturer.

E. Seal slip joist with duct sealant and secure with sheet metal screws.

F. Utilize flanged connectors for duct sizes requiring reinforcement and for flat oval ducts to prevent sagging.

G. Seal flanged connectors with approved gasketing and secure flanges with nuts and bolts.

H. Install O-ring joints per manufacturer’s requirements.

3.03 ADDITIONAL INSTALLATION REQUIREMENTS OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.04 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood. If the duct run exceeds 75 feet (22 m), the duct shall be sloped at a minimum of 8.3 percent.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 12 feet in horizontal ducts, and at every floor for vertical ducts, and as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.
1. A sign shall be placed on all access panels stating: ACCESS PANEL - DO NOT OBSTRUCT in letters at least 1 inch (25 mm) high.
2. Size of panel shall allow for easy cleaning of all interior duct surfaces.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

D. All elbows shall be smooth radius with a center line radius to width ration of 1.0, minimum.

E. No turning vanes, splitter dampers, extractors or manual volume dampers shall be installed.

3.05 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL DISHWASHER AND WET EXHAUST SYSTEMS DUCT

A. Exhaust duct shall pitch back to equipment without traps or low points.

B. All associated exhaust ductwork shall be air and water tight by means of externally welded, ground and polished joints and seams. Welded seam shall be located at one of the top corners of the duct.

3.06 ADDITIONAL INSTALLATION REQUIREMENTS FOR BATH OR SHOWER EXHAUST DUCT CONSTRUCTION

A. All associated exhaust ductwork shall be air and water tight by means of externally welded, ground and polished joints and seams. Welded seam shall be located at one of the top corners of the duct.

B. For bathrooms with only one shower or bath, the branch runout to the exhaust grille shall be aluminum. Sealant may be used in lieu of welding for these branches.

3.07 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and other Division 23 specification sections.

B. Hanger and support Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," for maximum hanger and support spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

C. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.08 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.09 FIELD QUALITY CONTROL

A. Perform visual inspections of installed ductwork to assure that there aren't any gaps or leaks which would degrade system performance.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." with the allowable leakage values summarized in the table below. Submit a test report for each test.

Duct Pressure Class - P	½", 1", 2" wg	3" wg	4", 6", 10" wg
Leakage Class (CFM per 100 Sq. Ft.. of Duct Surface Area), $F_{leakage} = CL \times P^{.65}$			
Rectangular Metal (CL)	24	12	6
Round Metal (CL)	12	6	3

   2. Test the following systems:
      a. Supply Ducts with a Pressure Class of 2-Inch wg or 3-Inch wg: Test representative duct sections from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class in each system.

b. Supply Ducts with a Pressure Class of 4-Inch wg or Higher: Test 100 percent of total installed duct.
c. Return, Exhaust, and Outside Air Ducts with a Pressure Class of 2-Inch wg or higher: Test representative duct sections from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class in each system.
d. Test all vertical shafts and all supply and return ducts located outside of the building envelope (across the roof, attics, mechanical rooms vented to the outside etc.) regardless of pressure class.

3. Duct leakage tests shall be performed while duct sections are being installed prior to installation of external insulation and finished ceilings.
4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
5. Conduct leakage testing of ductwork at pressure rating of the duct section, positive pressure or negative pressure as specified. Increase air flow from leakage test fan gradually to prevent over pressurization of ducts. The leakage amount shall not exceed the allotted Leakage Class amount for that portion of the system.
6. Do not pressurize systems above maximum design operating pressure.
7. If excessive air leakage is found during leakage testing, locate leaks, seal, repair and repeat Leakage Test.
8. Submit reports for review during the Construction process.

3.10 DUCT CLEANING

A. Ductwork shall be installed with cleanliness that exceeds SMACNA’s Advanced Duct Cleanliness Level as defined in SMACNA's "Duct Cleanliness for New Construction Guidelines."

B. Clean ductwork internally of dust and debris, unit-by-unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of the facing.

C. Clean exposed duct systems of all dust, debris, foreign substances, and shop fabrication identification marks or stickers. Refer to Architectural requirements for painting of exposed duct systems.

D. Provide temporary duct closures of polyethylene film or other covering to prevent the entrance of dust and debris until the time connections are completed

3.11 DUCT SCHEDULE

A. Fabricate ducts as indicated in the following table:

	Galvanized Sheetmetal	Aluminum Sheet	Stainless Steel Sheet	Black Steel (Uncoated)	Fiber Duct Board	Flexible Duct	**REMARKS**
Mixed Air Duct & Plenum "interior"	X						
Supply,Return, Exhaust & O.A Ducts "interior"	X						
Supply, Return, Exhaust & O.A. Ducts "exterior"	X		Opt.				
Supply/Return Branch Run-outs “Interior”	See Remarks					X	Refer to details. Sheet metal is required for critical care applications in Healthcare Facilities
Transfer Ducts "interior"	See Remarks				X		Refer to details. Sheet metal is required for Healthcare Facilities
Humidifiers/Clg. Coils			X				
Ducts in Corrosive environments			X				PVC Coated Galvanized-steel sheet may be used as an option.
Shower Branch Exhaust		X	Opt.				
Dishwasher, group showers or other "wet" Exhaust Systems		Opt.	X				

B. All ducts shall have a Seal Class of A, regardless of pressure class, unless noted otherwise.

C. Unless otherwise indicated on the drawings or specifications, construct all ductwork for a minimum pressure class equivalent to the positive or negative static pressure at the fan entrance or discharge, or for a 2 inch w.g. pressure class, whichever is greater.
   1. Ductwork from air handling unit discharge connection to the inlet connection at the air terminal device or reheat coil shall be constructed to a minimum of 4” w.g. positive pressure class.
   2. Ductwork downstream of the air terminal device or reheat coil shall be constructed to a minimum of 2” w.g. positive pressure class.
   3. Return, exhaust and outside air ductwork shall be constructed to minimum of 2” w.g. negative pressure class

D. Duct Reinforcement: Provide duct bracing to meet pressure class per SMACNA Standards.
   1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.
   2. PVC-Coated Ducts: Match duct material.
   3. Stainless-Steel Ducts: Match duct material.
   4. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.
   5. Flat Oval Ducts: Reinforce negative pressure ducts in accordance with SMACNA’s requirements for rectangular duct systems.

E. Double wall duct:
   1. Apply manufactured double wall duct with perforated inner wall and polyester film to the following ductwork:
      a. Exposed ductwork requiring insulation.
      b. Ductwork as indicated.
   2. Lined and double wall ducts do not require external insulation, unless indicated otherwise

3.12 DUCT LINER

A. Duct liner is required to reduce noise levels.

B. Apply lining manufactured double wall duct with perforated inner wall and polyester film to the following ductwork:
   1. Supply ducts for 25 feet from fan or air handling unit discharge.
   2. Return ducts for 25 feet from fan inlet or air handling unit return.
   3. Ductwork as indicated.
   4. All air transfer ducts.
   5. Exhaust ductwork for 15 feet from fan inlet.

C. Apply lining to the following ductwork:
   1. All rectangular ductwork a minimum of 6 feet downstream of air terminal devices such as VAV boxes.

D. Do not apply lining or double wall duct to the following ductwork:
   1. Outdoor air intake ductwork.
   2. Kitchen exhaust ductwork.
   3. Dishwashing exhaust ductwork.
   4. Ductwork manufactured with glass fiber ductboard.
   5. Shower exhaust ductwork.
   6. All ductwork associated with pool ventilation system.
   7. Supply, return and exhaust ductwork associated with shop ventilation systems where air handling units are located in the shops.
   8. Supply ductwork associated with ventilation systems serving hospital critical areas.

E. Lined and double wall ducts do not require external insulation, unless indicated otherwise.

END OF SECTION

SECTION 233300

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Backdraft and barometric dampers.
   2. Manual volume dampers.
   3. Fire dampers.
   4. Smoke dampers.
   5. Combination fire and smoke dampers.
   6. Ceiling radiation dampers.
   7. Flange connectors.
   8. Turning vanes.
   9. Remote damper operators.
   10. Duct-mounted access and pressure relief doors.
   11. Flexible connectors.
   12. Flexible ducts.
   13. Runout duct fittings
   14. Duct accessory hardware.

B. Related Sections include:
   1. Division 23 Section “Instrumentation and Control for HVAC”.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Air pressure drop scheduled includes both catalog and system effect pressure loss of the silencer. Submittal pressure drops to include system effect factors based upon the inlet and discharge conditions. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: Coordinate with ductwork specifications.
   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.
      f. Duct silencer installation including distance to duct fittings
      g. Wiring Diagrams: For power, signal, and control wiring.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.05 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10 percent of amount installed

1.06 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Material of product shall match ductwork material.

B. 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.

2.02 BACKDRAFT AND BAROMETRIC 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. Greenheck Fan Corporation.
   3. Nailor Industries Inc.
   4. Pottorff; a division of PCI Industries, Inc.
   5. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm.

D. Minimum Pressure Rating: 2-inch wg or pressure rating of ductwork whichever is greater.

E. Frame: 0.052-inch-thick, galvanized sheet steel, 0.063-inch-thick extruded aluminum or 0.052-inch-thick stainless steel, with welded corners and mounting flange to match ductwork material.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl or polyurethane, mechanically locked.

I. Blade Axles:
   1. Material: Stainless steel .
   2. Diameter: 0.20 inch.

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Barometric Damper Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.

2.03 MANUAL VOLUME 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. Greenheck.
   3. McGill AirFlow LLC.
   4. METALAIRE, Inc.
   5. Nailor Industries Inc.
   6. Pottorff; a division of PCI Industries, Inc.
   7. Ruskin Company.
   8. VentLock

B. Standard leakage rating, with linkage outside airstream.

C. Suitable for horizontal or vertical applications.

D. Frames:
   1. Hat-shaped, channels, 0.052-inch-thick, galvanized sheet steel, 0.063-inch-thick extruded aluminum or 0.052-inch-thick stainless steel to match the material of the duct in which they are installed.
   2. Mitered and welded corners.
   3. Flanges for attaching to walls and flangeless frames for installing in ducts.

E. Blades:
   1. Multiple blade for ducts over 12 inches in height.
   2. Single blade for ducts up to 12 inches in height.
   3. Parallel- or opposed-blade design.
   4. Stiffen damper blades for stability and to prevent vibration, flutter, or other foreign noise.
   5. 0.064 inch thick in the same material as the duct the damper is installed.

F. Blade Axles: the same material as the duct the damper is installed.

G. Bearings:
   1. Molded synthetic.
   2. 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.

H. Tie Bars and Brackets: same as duct material.

2.04 FIRE 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. Greenheck.
   3. Nailor Industries Inc.
   4. Pottorff; a division of PCI Industries, Inc.
   5. Price
   6. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours, compatible with assembly being installed in.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel or stainless steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. 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 appropriate for the installation.

H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized steel or stainless steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel or stainless steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F unless specifically identified to be 212 deg F rated, fusible links.

2.05 SMOKE DAMPERS

A. Manufacturers:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Greenheck.
   3. Nailor Industries Inc.
   4. Pottorff; a division of PCI Industries, Inc.
   5. Price
   6. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Frame: Multiple-blade type; fabricated with roll-formed, 0.062-inch-thick galvanized steel; with mitered and interlocking corners.

E. Blades: Air foil, horizontal, interlocking, 0.078-inch-thick, galvanized sheet steel.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.062-inch-, or duct thickness whichever is greater, thick, galvanized sheet steel; length to suit wall or floor application.

I. Damper Motors/Actuators:
   1. Two-position action.
   2. Electrical Connection: 24 Vac. If site conditions require the use of 120 V actuators, coordinate power requirements with Division 26 contractor.
   3. Actuators shall include the following:
      a. Actuator shall be furnished factory mounted to the damper with UL555(S) listing by the damper manufacturer for temperature rating of 350° F.
      b. Provide spring fail safe return. Provide normally open or closed position as indicated in the points list or sequence of operation

J. Accessories:
   1. Auxiliary switches for position indication.
   2. Momentary test switch, damper mounted.

2.06 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers:
   1. Air Balance Inc.; a division of Mestek, Inc.
   2. Greenheck.
   3. Nailor Industries Inc.

4. Pottorff; a division of PCI Industries, Inc.
5. Price
6. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: Coordinate with Life Safety Plan

E. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

F. Frame: Multiple-blade type; fabricated with roll-formed,0.062-inch-thick galvanized steel; with mitered and interlocking corners.

G. Blades: Roll-formed, horizontal, interlocking, 0.078-inch-thick, galvanized sheet steel.

H. Leakage: Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 0.062-inch-, or duct thickness whichever is greater, thick, galvanized sheet steel; length to suit wall or floor application.

K. Master control panel when used in dynamic smoke-management systems.

L. Damper Motors/Actuators:
1. Two-position action.
2. Electrical Connection: 24 Vac. If site conditions require the use of 120 V actuators, coordinate power requirements with Division 26 contractor.
3. Actuators shall include the following:
   a. Actuator shall be furnished factory mounted to the damper with UL555(S) listing by the damper manufacturer for temperature rating of 350° F.
   b. Provide spring fail safe return. Provide normally open or closed position as indicated in the points list or sequence of operation

M. Accessories:
1. Auxiliary switches for position indication.
2. Momentary test switch, damper mounted.

2.07 CEILING RADIATION 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. Greenheck.
3. METALAIRE, Inc.
4. Nailor Industries Inc.
5. Pottorff; a division of PCI Industries, Inc.
6. Ruskin Company.
7. Or equal standard product of specified diffuser, register and grille manufacturer.

B. General Requirements:
1. Labeled according to UL 555C by an NRTL.
2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F unless specifically identified to be 212 deg F rated, fusible links.

F. Fire Rating: 2 or 3 hours, compatible with assembly being installed in.

2.08 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Nexus PDQ; Division of Shilco Holdings Inc.
   3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.09 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Vane Construction:
   1. Large 4.5” radius 3.25” on center single wall for ducts up to 48 inches wide
   2. Large 4.5” radius 3.25” on center double wall for larger dimensions .
   3. If duct sizes change in a mitered elbow or tee, use large single wall type with trailing edge.

2.10 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc.
   2. United Enertech.
   3. Ventfabrics, Inc.
   4. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment via rack an pinion remote control operators.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box and Ceiling-Box Mounting: Recessed, 2 inches (50 mm) deep .

F. Wall-Box and Ceiling-Box Cover-Plate Material: Stainless steel or Chrome Plated.

G. Linear Diffusers and Linear Returns. Provide plenum mounted cable controller for mounting in the air plenum behind the face of the unit.

2.11 DUCT-MOUNTED ACCESS AND PRESSURE RELIEF DOORS

A. General: Fabricate access doors according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Provide pressure relief type per Part 3 requrements.

B. Duct Access Door
   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 sash locks.
      b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
      c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
      d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
      e. All exposed duct, regardless of size, requires hinges.

C. Pressure Relief Door:
   1. Provide positive and/or negative pressure relief doors as manufactured by Ruskin Model PRD18 or NRD18, or approved equal.
   2. Door and Frame Material: Galvanized sheet steel.
   3. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
   4. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
   5. Factory set at 1-inch wg increments over a range of 3-inch wg to 10-inch wg.
      a. Positive pressure doors shall be set at 125% duct static pressure class. For 4” pressure class duct, set at 5” WG positive.
      b. Negative pressure doors shall be set at minimum setting of 3” WG negative.
   6. Doors close when pressures are within set-point range.
   7. Hinge: Continuous piano.
   8. Latches: Cam.
   9. Seal: Neoprene or foam rubber.
   10. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

D. Duct Access Door with Pressure Relief:
   1. Positive pressure duct high pressure access door with negative pressure relief doors as manufactured by Ruskin Model ADHP-3 or approved equal.
   2. Door and Frame Material: Galvanized sheet steel.
   3. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
   4. Operation: Spring opens inward for negative-pressure relief in positive pressure ducts.
   5. Factory set at 1-inch wg negative pressure, non adjustable.
   6. Doors spring close when negative pressure condition is eliminated.
   7. Latches: Spring type for negative pressure relief.
   8. Seal: Neoprene or foam rubber.
   9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.12 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide fire rated products by one of the following:
   1. Ductmate Industries, Inc.
   2. 3M.
   3. Milcor Fire-Rated Access Doors by Greenheck.
   4. Milcor Fire-Rated Access Doors by Inryco, Inc.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon or 0.0428-inch stainless steel to match duct.

D. Fasteners: Carbon or Stainless steel, to match duct. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.13 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd..
   2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
   3. Service Temperature: Minus 50 to plus 250 deg F.

F. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
   1. Minimum Weight: 14 oz./sq. yd..
   2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.14 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Flexmaster U.S.A., Inc.
   2. Thermaflex

B. Factory fabricated suitable for pressures and temperatures involved. Flexible duct Underwriters' Laboratories listing, UL-181 Class 1 duct and NFPA 90A a flame spread of 25 or less and a smoke developed rating of 50 or under.

C. Pressure Rating of flexible duct, 6 inch w.g.(1500 Pa) positive, 1 inch w.g.(250 Pa) negative , rated for a velocity of at least 4000 fpm (20 m/s) unless otherwise specified.

D. Temperature rating of flexible duct, continuous operation at a temperature range of -20°F to +250°F. (Minus 29 to plus 126 deg C) unless otherwise specified.

E. Insulated flexible duct shall be constructed of an inner air barrier liner supported by and mechanically locked to a helical wound galvanize steel helix without the use of adhesives or chemicals. Factory-insulate the flexible duct with fiberglass insulation with an R value of 6 minimum at a mean temperature of 75 F. Cover the insulation with a fire retardant metalized vapor barrier jacket reinforced with crosshatched scrim having a permeance of not greater than .05 perms when tested in accordance with ASTM E96.

F. Acoustical Insulated, Flexible Duct: Inner air barrier liner, acoustically transparent CPE air impervious fabric, Flexmaster Type 1M, Thermaflex Type M-KE or approved equal.
   1. Sound Performance: Minimum Insertion Loss for 10 foot length straight duct at a velocity of 2500 feet per minute rated in accordance with Air Diffusion Council Test Code FD 72-RI.

Octave Band	2	3	4	5	6	7
Hz	125	250	500	1000	2000	4000
6-in	11	33	37	39	37	19
8-in	13	35	34	39	29	17
12-in	10	26	26	35	24	11

G. Flexible Duct Connections:
   1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action or Nylon strap to match duct material and to suit duct size. Sheet metal screws will not be allowed.

2.15 RUNOUT DUCT FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following;
   1. Elgen.
   2. Flexmaster.
   3. Sheet Metal Connectors, Inc.
   4. Or approved equal

B. Description: Factory-fabricated conical fittings for sheet metal or ductboard with integral volume damper. Utilize side takeoff fittings with integral volume damper with 45 degree slope on upstream side or 45 degree slopes on upstream and downstream side when indicated on the drawings or as required by duct configuration. Utilize to connect runout ducts from diffusers and grilles to submains.

C. Construction:
   1. Low leakage welded seam galvanized steel, stainless or aluminum to match the material of the duct in which they are installed.
   2. Spin in construction or flanged construction with neoprene gasket.
   3. Integral single damper blade, 3/8” square shaft, U.bolt, nylon bushings, 2” buildout stand- off handle with locking damper quadrant handle. Dampers to be fabricated with to prevent vibration, flutter or other noise. Stand-off handle not required for non-insulated duct systems.
   4. Round outlet with rolled stiffener bead for strength and sealing runout ducts.
   5. Side takeoff fittings to maintain a ratio of 1 to 1 of inlet to outlet area.
   6. Overall length of fitting not to exceed 13”.

7. Utilize 4”W.G. construction with or without damper as shown on the drawings when connecting to 4” pressure class duct.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft and barometric dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan or elsewhere indicated on the plans and except those specified to be by the fan manufacturer and where motor operated dampers are shown or specified to be located in the discharge ductwork.

D. Install control dampers under the coordinating control and supervision of the control contractor as specified in Section Instrumentation and Control for HVAC, in locations indicated on the drawings, as detailed and according to manufacturer’s instructions.
   1. Provide adequate operating clearance and access to operator.
   2. Dampers, individual or multiple section assemblies, must be completely square and free from racking, twisting, or bending.
   3. Unless specifically designed for vertical blade application, dampers must be mounted with blade axis horizontal.
   4. Damper blades, axles, and linkage must operate without binding. Before system operation, cycle damper after installation to ensure proper operation. On multiple section assemblies, all sections must open and close simultaneously.
   5. Provide a visible and accessible indication of damper position on the drive shaft end.
   6. At inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

E. Install manual volume dampers at points on supply, return, exhaust and outside air systems at all branches extending from larger ducts, including run-outs to diffusers and grilles, in addition to the dampers indicated on the plans, and as necessary to regulate the flow of air meeting the air balance requirements. 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.

F. Utilize runout duct fittings for runout duct to diffusers, registers and grilles where duct configuration permits, unless indicated otherwise. Fittings shall be secured and sealed to duct connections in accordance ductwork specifications.

G. Locate volume dampers as close to main duct as possible unless indicated otherwise.

H. Install dampers so as to not flutter or vibrate.

I. Damper handles shall be installed with stand-off handle to be mounted exterior to insulated ducts.

J. Attach a 24 inchlong fluorescent orange plenum rated “surveyors” tape at all dampers to assist in locating dampers upon completion of installation for test and balance.

K. Install remote damper operators at all volume dampers in inaccessible locations such as above gypsum board ceilings.

L. Install fire dampers according to UL listing, NFPA 90A, and the manufacturer’s installation instructions. Install complete with mounting collars, retaining angles, connections to ductwork and duct access doors.

1. Curtain-type fire damper sizes shall be based upon free area of duct, so the damper blades shall not reduce the free area of the airstream.
2. Multiple Fire Dampers – if a duct requiring a fire damper is larger than the biggest available curtain-type fire damper size, then two or more multi-blade type fire dampers shall be used instead of multiple adjacent curtain-type dampers.

M. Install smoke and combination fire/smoke dampers according to UL listing, NFPA 90A, and the manufacturer's installation instructions. Install complete with mounting collars, retaining angles, connections to ductwork and duct access doors.

N. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
1. On upstream side of duct coils.
2. At outdoor-air intakes and mixed-air plenums.
3. At drain pans and seals.
4. Adjacent to and close enough to fire, smoke or fire/smoke dampers, to reset or reinstall fusible links and observe position of damper blades.
5. At duct smoke detectors.
6. At control devices requiring inspection.
7. Upstream of elbows with turning vanes.
8. Elsewhere to service equipment.

O. Ceiling access panels shall be provided, where required, to service dampers, heaters, valves and other concealed mechanical equipment,

P. Install duct pressure relief doors on AHU and fan duct systems. The relief pressure value shall be the maximum static pressure rating of the duct to prevent expansion from over-pressure on the supply side, and to prevent collapse due to excessive low pressure on the return/exhaust side. Pressure relief doors shall be installed in systems that meet any of the following:
1. Airflow greater than 5,000 cfm and velocity greater than 2,000 fpm: Install on the positive and negative sides of fans (AHU, supply, exhaust) between the fan and the first (fast-acting) fire damper. Size relief doors for 75% of the rated flow at maximum static pressure of:
   a. Supply ducts at 5" WG, minimum size 24X12.
   b. Return ducts or exhaust ducts at 3" WG, minimum size 24X12.
2. Duct static pressure greater than 2.5": Install on the positive and negative sides of (fast-acting) fire dampers in the region where the duct static pressure is normally operating at 2.5". (Refer to Ruskin Engineering Report 8190:2 Use of Access Doors in Duct Design Downstream of Dampers) Size relief doors for the duct rated flow at:
   a. Supply ducts at 5" WG.
   b. Return or exhaust ducts at 3".
   c. For supply ducts only, downstream of fast acting damper a combination Duct Access Door with Pressure Relief may be used in lieu of a separate access door and pressure relief door.

Q. Provide hinged access doors in exposed applications and cam-latch type in concealed installations.

R. Access Door Sizes:
1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

S. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

T. Install flexible connectors to connect ducts to equipment containing rotating or vibrating equipment, with not less than 4-incheslength of material and in accordance with SMACNA.

U. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

V. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions or to compensate for misalignment of inlet duct to terminal unit.

W. When specified, connect supply diffusers and return grilles to ducts with flexible duct clamped or strapped in place. Minimum length of flex duct to each diffuser shall be 8'-0" with a maximum length of 12'-0" and include at least one 90 degree radius elbow.

X. Connect flexible ducts to runout fittings, sleaves and air devices per manufacturer's installation instructions:
   1. Up to 3" duct construction: 2 wraps of approved tape and draw band to secure inner core.
   2. Over 3" duct construction: sealer, 2 wraps of approved tape and draw band to secure inner core.
   3. For metal type flex additionally secure with sheet metal screws.
   4. For insulated flex, seal outer jacket as specified for duct insulation.
   5. When connecting flexible duct to round metal duct utilize metal connecting sleave to maintain duct shape.

Y. Flexible duct is not permitted in Healthcare Facilities for critical care applications.

Z. Supply and Return flex duct shall be insulated. Exhaust flex duct shall not be insulated unless part of an energy recovery system.

AA. For high pressure fan discharge, install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 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/smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 233400

FANS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Centrifugal roof ventilators.
   2. Manufacturer's Roof Curbs

B. Related Sections include the following:
   1. Division 23 Section "Common Motor Requirements for HVAC equipment".
   2. Division 23 Section "Hangers and Supports for HVAC Piping and Equipment".
   3. Division 23 Section "Seismic Restraint for HVAC".
   4. Division 23 Section "Vibration Controls for HVAC".

1.03 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level unless otherwise indicated.

B. Operating Limits: Classify according to AMCA 99.

C. Seismic: Fans and curb mounting assemblies shall withstand the effects of seismic forces in accordance with project Seismic specifications.

1.04 ACTION SUBMITTALS

A. Product Data:
   1. Include rated capacities, furnished specialties, dimensions, weights and accessories for each fan.
   2. Certified fan performance curves with system operating conditions indicated. Fan curves shall include a series of curves indicating the relationship of CFM and static pressure for various RPM. Brake horsepower curves shall also be included. Indicate the design operating point clearly on the fan curves. Indicate fan brake horsepower requirement at the design operating point.
   3. Certified octave band fan sound-power ratings.
   4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   5. Material thickness and finishes, including color charts.
   6. Dampers, including housings, linkages, and operators.
   7. Diagrams for power, signal, and control wiring

1.05 INFORMATIONAL SUBMITTALS

A. Wind compliance: Contractor's certification of compliance with wind structural loading requirements of the Building Code, wind loads identified in "Performance Requirement" article and Authority Having Jurisdiction. Submit as applicable:
   1. Product Approval: Equipment specific documentation indicating compliance.
   2. Delegated Design: Signed and sealed documents by registered engineer.
   3. Dimensioned Outline Drawings of Equipment: Identify maximum rated wind force in pounds per square foot, mounting and anchorage provisions.
   4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE 7 special seismic certification as required. Include method used to determine compliance with requirements.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements

C. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans to include in operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Belts: One set for each belt-driven unit.

1.08 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. Comply with UL-705.

1.09 COORDINATION

A. Coordinate size and location of structural-steel support members and concrete bases where applicable.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations, where applicable.

1.10 DESIGN CRITERIA

A. All fans shall be tested as complete units in accordance with the applicable test code of AMCA and shall be certified by AMCA.

B. All fans with belt drives shall be provided with variable pitch V-belt sheaves for purpose of system balancing. After system is balanced, fixed pitch sheaves shall replace the variable pitch sheaves for all motors using multiple belt drives.

C. Each fan and motor combination shall be capable of meeting the following conditions while maintaining stable fan performance: deliver plus or minus 10% of the air quantity scheduled at the scheduled static pressure; deliver the air quantity scheduled at 125% of the scheduled static pressure. Provide Class I, II or III fan construction as required. The motor furnished with the fan shall not operate into the motor service factor in any of these cases. Drive efficiency shall be considered in motor selection according to manufacturer's published recommendations, or according to AMCA.

D. Where inlet and outlet ductwork at any fan is changed from that shown on the drawings, Contractor shall submit a scaled layout of the change and system effect factor calculations, indicating increased static pressure requirements as described in AMCA. This Contractor shall be responsible for any motor, drive and/or wiring changes required as a result of duct configuration changes at fan.

E. Where fan drives are exposed use OSHA approved belt guards that totally enclose the entire drive. Construct guards of expanded metal to allow for ventilation. Provisions shall be made so that tachometer may be used to verify fan speed without removing the guard assembly.

F. All internal insulation and other components exposed to the airstream are to meet the flame spread and smoke ratings contained in NFPA 90A.

G. Statically and dynamically balance all fans so they operate without objectionable noise or vibration.

H. Fan size, fan class, wheel type, inlet type, capacity, arrangement operating characteristics and any other special requirements shall be as indicated on the plans and/or as scheduled.

I. All fans serving a “fume” application (i.e., fume hoods) shall be completely coated internally with a baked phenolic coating, minimum 4 mils thick.

J. Fan bearings shall be heavy duty grease lubricated, ball or roller type selected for a Basic Rating Life (L_{10}) of at least 80,000 hours unless otherwise indicated in the fan product section. All bearings shall be factory lubricated and equipped with standard hydraulic grease fittings and lube lines extended to the motor side of the fan.

K. All belt-driven drive assemblies shall be factory mounted, with final alignment and belt adjustment made after installation. Fan shafts shall be turned, ground and polished steel and keyed to wheel hub. Fan Pulleys shall be Cast iron with split, tapered bushing and dynamically balanced at factory. Motor Pulleys shall be adjustable pitch. Select motor pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Belts shall be oil resistant, nonsparking, and nonstatic with matched sets for multiple belt drives. Motor mounts shall have an adjustable base. Fan and motor shall be isolated from the exhaust air stream unless otherwise indicated.

L. All V-belt drives shall be designed for 150% of motor rating.

M. For direct drive fans with VFDs and bypass starter, select fan to operate at or above the fan’s motor speed to allow fan operation in bypass mode.

N. Provide stainless steel fasteners to secure fan to curb.

O. Provideelectrically commutated motors (ECM) for all direct drive fans with single phase motors.

P. Provide backdraft or motorized dampers for fans where required by the plans and/or schedules. Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve or roof curb; factory set to close when fan stops. Motorized dampers shall be parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

Q. Exhaust fans and attachments to structure shall be designed to conform with the wind and seismic structural loading requirements identified in “Performance Requirement”.

R. Forward curved fans may be provided when scheduled and when static pressure differential at fan is 1.5” W.G. or less.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ACME Engineering & Mfg. Corp.
   2. Carnes Company
   3. Greenheck Fan Corporation
   4. Loren Cook Company
   5. PennBarry
   6. Twin City Fan

B. Description: Roof mounted direct- or belt-driven centrifugal fans with motor out of air stream consisting of housing, wheel, fan shaft, bearings, motor, starter and disconnect switch, drive assembly, curb cap, and accessories.

C. Housing: Aluminum along with curb cap, windband and ventilated motor compartment with removable housing. Curb cap with integral venturi inlet cone.
   1. Upblast Units: If listed on the plans, provide design of wind band to direct discharge air upward, with rain and snow drains and welded curb cap for waterproof construction.
   2. Wireways: Integral internal wiring conduits for all power and control wiring for fan and curb.
   3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   4. Vibration Isolation: factory installed vibration isolators for drive assembly.

D. Fan Wheels: Aluminum hub and wheel with non-overloading backward-inclined blades.

E. Accessories:
   1. Dampers: Counterbalanced or motor operated as scheduled, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
   2. Direct Drive Speed Controller

F. Roof Curbs: Straight sided curb of heavy gauge galvanized steel; mitered and welded corners with 4” minimum bottom flange, structural curb for positive attachment of fan to structure; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; curb seal. Size as required to suit roof opening and fan base.
   1. Coordinate curb height with roof insulation thickness, and with other criteria such as snow. Minimum curb height is 18” to provide a minimum of eight (8) inches above finished roof.
   2. Pitch Mounting: Manufacture curb for roof slope.
   3. Damper holding tray: For fans scheduled with dampers.

2.02 MOTORS

A. Comply with NEMA designation, temperature rating, service factor and efficiency requirements for motors as specified in Common Motor Requirements for HVAC equipment specifications.

B. Single phase motors to include integral thermal overload protection.

2.03 ELECTRICAL

A. Fans shall be supplied with NEMA motor controllers, means of disconnect and overcurrent protection in accordance with mechanical, control and electrical specifications.

B. Disconnect Switch: Nonfusible type factory mounted. Locate within motor compartment for exterior applications, factory wired to motor.

C. Furnish each variable speed three phase motor with field mounted variable frequency drive, VFD, with bypass, circuit breaker or fused disconnect switch, transformers, and all necessary motor starter, contactor and overcurrent protection. Locate remotely in an enclosed location for exterior applications.

D. Furnish each constant speed three phase motor with field mounted fusible combination motor starter/disconnect switch, transformers, and all necessary motor starter, contactor and overcurrent protection. Locate remotely in an enclosed location for exterior applications.

E. Direct Drive Speed Controller – Manually adjustable type for constant volume operation and automatic modulating or two speed type for automatic control suitable for PSC or ECM single phase motors.

2.04 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.01 INSTALLATION

A. Compliance: In accordance with approved submittals and manufacturer's written installation instructions.

B. Comply with mounting and anchoring requirements for seismic and/or wind installations.

C. Secure fan and curb mounting assemblies to structure with positive attachments in accordance project's seismic loading requirements.

D. Secure exterior fans and curb mounting assemblies to structure with positive attachments in accordance with project's seismic and/or wind loading requirements.

E. Wind and impact certified fans and mounting assemblies additionally shall comply with requirements of current certification. All power wiring, control wiring, controllers, motor starters and unit disconnects shall be concealed and protected from wind and impact by equipment and curb assemblies.

F. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hanger

G. Install floor-mounting units on concrete bases with vibration isolation per specifications.

H. Secure roof-mounting fans to roof curbs with stainless or cadmium-plated hardware. Install units with clearances for service and maintenance. In no case, shall the access and service space around and over fans less than that recommended by manufacturer.

I. Install work readily accessible for normal operation, reading of instruments (in vertical position), adjustment, service, inspection and repair. Provide access panels where indicated and required. Access panels shall be the responsibility of the respective subcontractor.

3.02 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Install ducts adjacent to fans to allow service and maintenance.

B. For fans with drain, install a drain valve with screwed cap.

C. Provide internal wiring conduits so that all electrical and control wiring penetrates the building envelope within the interior of the roof curb to eliminate exposed wiring and conduit.

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete.
   3. Verify that thermal-overload protection is provided for motors.
   4. Verify that cleaning and adjusting are complete.
   5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
   6. Adjust belt tension.
   7. Adjust damper linkages for proper damper operation.

8. Verify lubrication for bearings and other moving parts.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
11. Shut unit down and reconnect automatic temperature-control operators.
12. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fans.

3.05 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Replace fan and motor pulleys as required to achieve design airflow. After system is balanced, replace the variable pitch sheaves with fixed pitch sheaves.

D. Lubricate bearings.

END OF SECTION

SECTION 233433

AIR CURTAINS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes air curtains.

B. Related Sections include the following:
   1. Division 23 Section "Seismic Restraint For HVAC Piping and Equipment" for requirements necessary for compliance with seismic criteria

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties, and accessories.

B. Shop Drawings: For air curtains. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Warranties: Sample of special warranties.

B. Seismic Qualification: Manufacturer’s certification of seismic qualification according to ASCE 7-05. Submit ASCE 7-05 special seismic certification as required. Include method used to determine compliance with requirements.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air curtains to include in maintenance manuals

1.06 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air curtains and are based on the specific product indicated. Refer to Division 01 Section "Product Requirements."

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 AMCA 220, "Test Methods for Air Curtain Units," for airflow, outlet velocity, and power consumption.

D. Comply with ARI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.
   1. Certify coils according to ARI 410.

1.07 COORDINATION

A. Coordinate layout and installation of air curtains and suspension system components with other construction, including light fixtures, fire-suppression-system components, and partition assemblies.

B. Coordinate installation of wall penetrations and louvers. These items are specified in Division 08 Section "Louvers and Vents."

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air curtains that fail in materials or workmanship within specified warranty period.
   1. Warranty Period (Nonheating Units): Five years.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below, before construction begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Furnish one set of filters and fan belts for each unit.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Berner International Corp.
   2. KING.
   3. Marley Engineered Products.
   4. Mars Air Products; Dynaforce Division.
   5. Mars Air Products; Mars Air Door Division.
   6. MesTec AG; L. J. Wing Division.

2.02 MATERIALS

A. Housing Materials: One-piece, molded, high-impact, white polymer material.

B. Housing Materials: Galvanized steel with electrostatically applied epoxy enamel finish over powdered mirror.

C. Housing Materials: Heavy-gage, electroplated-zinc steel with welded construction and polyester-coated finish.

D. Housing Materials: Heavy-gage, aluminum construction.
   1. Anodized Finish: Match finish and color of adjacent architectural metals. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   2. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
      a. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
      b. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker).
   3. Mounting Brackets: Steel, for wall or ceiling mounting.

E. Intake Louvers: Integral part of the housing, mechanically field adjustable and capable of reducing air-outlet velocity by 60 percent with louver in totally closed position.

F. Discharge Nozzle: Integral part of the housing, containing adjustable air-directional vanes with per the schedule -degree sweep front to back.

2.03 FANS

A. Fans: Centrifugal, forward curved, double width, double inlet; Galvanized steel, statically and dynamically balanced.

B. Fan Drives: Direct or Belt, equipped with belt guards and adjustable sheaves and pulleys for adjusting air-outlet velocity.

2.04 MOTORS

A. Motor Type: Multispeed, resiliently mounted, continuous duty, totally enclosed, fan cooled, with integral thermal-overload protection.

B. Bearings: Permanently sealed, lifetime, pre-lubricated, ball bearings.

C. Disconnect: Internal power cord with plug and receptacle.

2.05 FILTERS

A. Disposable Panel Filters: Factory-fabricated, viscous-coated, flat-panel-type, disposable air filters with glass-fiber media sprayed with nonflammable adhesive in cardboard or galvanized-steel frame.

B. Washable Panel Filters: Removable, stainless-steel, baffle-type filters with spring-loaded fastening; with minimum 0.0781-inch-thick, stainless-steel filter frame.

C. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

2.06 ACCESSORIES

A. Automatic Door Switch: Plunger type installed in door area to activate air curtain when door opens and to deactivate air curtain when door closes.

B. Start-Stop, Push-Button Switch: Manually activates and deactivates air curtain.

C. Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 0.5 seconds to 10 hours.

D. Motor-Control Panel: Complete with motor starter, 115-V ac transformer with primary and secondary fuses, terminal strip, and NEMA 250, Type 12 enclosure.

E. Mounting Brackets: Adjustable mounting brackets for drum-type roll-up doors.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions where air curtains will be installed for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install air curtains with clearance for equipment service and maintenance.

B. Comply with mounting and anchoring requirements for seismic installations.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air curtain to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. After installing air curtains completely, perform visual and mechanical check of individual components.
   2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Repair or replace malfunctioning units and retest as specified above.

3.05 ADJUSTING

A. Adjust belt tension.

B. Adjust motor and fan speed to achieve specified airflow.

C. Adjust discharge louver and dampers to regulate airflow.

D. Adjust air-directional vanes.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air curtains. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 233616

AIR TERMINAL UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Single-duct air terminal units (with or without reheat).
   2. Fan-powered air terminal units.

B. Related Sections include the following:
   1. Division 23 Section "Seismic Restraint For HVAC Piping and Equipment" for requirements necessary for compliance with seismic criteria

1.03 PERFORMANCE REQUIREMENTS

A. Products shall be suitable for the indicated service including piping system fluids, materials, pressures, and temperatures.

B. Hydronic coils and installation shall withstand the minimum design pressure and temperature and test pressure as specified in Division 23 Section “Hydronic Piping.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Air terminal units.
   2. Liners and adhesives.
   3. Sealants and gaskets.

B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.
   3. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.05 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Size and location of initial access modules for acoustic tile.
   3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Seismic Qualification: Manufacturer’s certification of seismic qualification according to ASCE 7-05. Submit ASCE 7-05 special seismic certification as required. Include method used to determine compliance with requirements.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements

C. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan-Powered-Unit Filters: Furnish one spare filter for each filter installed

1.08 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.09 DESIGN CRITERIA

A. Where any of the air terminal devices in this section are indicated on the drawings to control space conditions in conjunction with a reheat coil, that reheat coil may be furnished as an integral part of or standard accessory to the devices specified below.

B. Unless otherwise stated, construct unit casings of galvanized steel or aluminum meeting SMACNA or ASHRAE Standards. Insulate casings thermally and acoustically with insulation meeting requirements of NFPA 90A and UL-181.

C. Unless otherwise stated, units shall be pressure independent and maintain air volume within plus or minus 5% at all flow rates within its published capacity range regardless of systems air pressure.

D. All casings located downstream of high efficiency particulate air filters shall not be internally insulated. Provide units with necessary sound attenuators constructed of all metal as required to meet the sound requirement specified.

E. The air terminal device manufacturer, or his designated representative, will be required to verify the air terminal device performance and adjust or replace the device within the warranty period when it is determined that a problem exists in the area served by the device.

F. Actuators and linkages shall be furnished by the control contractor and factory installed by the unit manufacturer. Actuator shall be of the same manufacturer as the balance of the temperature control equipment used on the project. All actuators shall meet the requirements as specified under Division 23 Section – Instrumentation and Controls for HVAC. Standard actuators furnished by the unit manufacturer are also acceptable, provided the actuators are compatible with the control system.

G. The actuator and its controller shall be calibrated and factory set for the scheduled air flow rates. Units shall be capable of field calibration and readjustment with external gauge taps.

H. Units shall be capable of operating from the minimum inlet static pressure scheduled to 4 inches W.G. without exceeding NC 35. Provide sound attenuators as required to meet this requirement, whether the attenuators are specified or not.

I. Primary air volume damper sections shall not require periodic maintenance and shall be calibrated at the factory according to the schedule shown on the plans.

J. Sound ratings shall be derived from sound power levels as measured in accordance with ASHRAE Standard 36-72, with a reference level of 10-12 watts, and rated at NC levels with an 8 db room attenuation reduction.

1.10 COORDINATION

A. Coordinate layout and installation of air terminal units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 SINGLE-DUCT AIR TERMINAL UNITS (WITH OR WITHOUT REHEAT)

A. Manufacturers:
   1. Anemostat
   2. Carrier
   3. Enviro-Tec
   4. Krueger.
   5. METALAIRE, Inc.; Metal Industries Inc.
   6. Nailor Industries Inc.
   7. Price.
   8. Titus.
   9. Trane.

B. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

C. Casing: 0.034-inch steel.
   1. Casing Lining: 1/2-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
   5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.
   1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.
   2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 3 percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

F. Access: Access shall be provided to the control damper and operator via a removable bottom panel. Access panel shall allow adjustment and replacement of control damper and operator when installed internally. Provide adequate accessibility when control damper with operator is field installed.

G. Controls: Refer to Section 230913 – “Instrumentation and Control Devices for HVAC” and related Division 23 sections for control requirements, including sequence of operations.

2.03 FAN-POWERED AIR TERMINAL UNITS

A. Manufacturers:
1. Anemostat
2. Carrier
3. Enviro-Tec
4. Krueger.
5. METALAIRE, Inc.; Metal Industries Inc.
6. Nailor Industries Inc.
7. Price.
8. Titus.
9. Trane.

B. Configuration: Volume-damper assembly and fan in series or in parallel arrangement, as indicated on Drawings, inside unit casing with control components inside a protective metal shroud.

C. Casing: 0.034-inch steel.
1. Casing Lining: 1/2-inch-thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.
2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: ARI 880 rated, [**2**] [**3**] percent of nominal airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

E. Fan Section: Galvanized-steel plenum, with direct-drive, forward-curved fan with air filter and backdraft damper.
1. Motor: Permanent split capacitor type with integral thermal overload protection and permanently lubricated sealed bearings. Motors shall comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Speed Control: Infinitely, manually adjustable SCR for speed control.
   b. Refer to the plan schedules for motor voltages.
2. Blower capacity shall be rated "as run" in its acoustically lined cabinet section and control damper assembled as a unit. Capacity rating shall be determined per ASHRAE standards.
3. Motor shall be resiliently isolated from blower scroll housing.
4. Blower/motor assembly shall be resiliently isolated from acoustically lined cabinet section.
5. Air Filter: 2-inch (50-mm) thick, fiberglass throwaway, MERV 7 filter.
6. Filters shall be rated in accordance with ASHRAE standard 52.2.

F. Access: Access shall be provided to the blower/motor and the control damper and operator via a removable bottom panel to allow inspection and replacement of blower/motor. Access panel shall allow adjustment and replacement of control damper and operator when installed internally. Provide adequate accessibility when control damper with operator is field installed.

G. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; factory installed.
   1. Coil tubes shall be 0.016-inch thickness
   2. Coils shall be leak tested underwater to 300 psig.
   3. Number of coil rows and circuits shall be provided as required to meet the capacities as listed on the plan schedules.

H. Factory Mounted and Wired Controls: Electrical components shall be mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
   1. Control Transformer: Factory mounted class II for control voltage with terminal strip in control box for field wiring of thermostat and power source.
   2. Wiring Terminations: Fan and controls to terminal strip, and terminal lugs shall match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
   3. Disconnect Switch: Factory-mounted, non-fused type, door interlocking.

I. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

J. Controls: Refer to Section 230913 – “Instrumentation and Control Devices for HVAC” and related 2309XX sections for control requirements, including sequence of operations.

2.04 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880. Rate hot water coils in accordance with ARI 410.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

B. Comply with mounting and anchoring requirements for seismic installations.

C. START-UP, CALIBRATION AND FIELD TESTING LABORATORY TERMINAL UNITS
   1. All instruments shall be calibrated and records shall be kept of the associated calibration.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Hot water piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange. Refer to plan details for additional information.

D. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts” and “Nonmetal Ducts."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.03 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
   2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
   3. Operational Test: For fan powered unit, after electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 233713

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Ceiling diffusers.
   2. Registers and Grilles
   3. Plastic ceiling diffusers.

B. Related Sections:
   1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
   2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
   3. Division 23 Section “HVAC Insulation” for insulation of supply plenums.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.04 DESCRIPTION

A. All diffuser and register locations in ceilings and walls shall be coordinated with reflected ceiling plans and electrical and low voltage plans prior to submittal and installation.

B. Prior to submitting diffusers, registers and grilles to for review, and prior to ordering, verify the ceiling system and type of ceilings specified in each space and coordinate the air device mounting system and frame with the ceiling type indicated on the reflected ceiling plans in the architectural plan documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers for specialty products are listed under those articles. For all other diffusers, registers and grilles available manufacturers are as follows:
   1. Anemostat.
   2. Hart and Cooley, Inc.
   3. Kreuger
   4. METALAIRE, Inc.
   5. Nailor Industries Inc.
   6. Price Industries.
   7. Titus.
   8. Tuttle and Bailey.

2.02 CEILING DIFFUSERS

A. Construct diffusers of aluminum unless otherwise indicated, and provide with the frame type appropriate to the installation.

B. Provide diffusers with air straighteners.

C. Perforated face ceiling diffusers shall have field adjustable pattern controllers accessible through a removable or hinged face plate.

D. Furnish round or square neck duct adapters for each unit for top connection or side connection as appropriate to the space.

E. Accessories:
   1. Equalizing grid.
   2. Plaster ring.
   3. Safety chain.
   4. Wire guard.
   5. Sectorizing baffles.
   6. Operating rod extension.

F. Diffuser models, sizes and finishes shall be as shown on the plans and/or as scheduled. Unless noted otherwise, diffusers shall have a baked enamel finish with color to be selected by the Architect.

2.03 REGISTERS AND GRILLES

A. Construct registers and grilles of aluminum unless otherwise indicated, and provide with the frame type appropriate to the installation.

B. Supply registers and grilles shall be double deflection type blades to provide for air deflection adjustment in all directions.

C. Return and exhaust registers and grilles shall have a core of fixed blades.

D. Furnish supply grilles complete with opposed blade volume control dampers, operable from the face.

E. Register and grille models, sizes and finishes shall be as shown on plans and/or as scheduled. Unless noted otherwise, registers and grilles shall have a baked enamel finish with color to be selected by the Architect.

2.04 PLASTIC CEILING DIFFUSERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eger Products Inc.
   2. Hart & Cooley
   3. Price

B. Construct diffusers of plastic, and provide with frame type appropriate to the installation.

C. Provide diffusers with air straighteners.

D. Perforated face ceiling diffusers shall have field adjustable pattern controllers accessible through a removable or hinged face plate.

E. Furnish round or square neck adapters for each unit for top connection or side connection as appropriate to the space.

F. Accessories:
   1. Equalizing grid.
   2. Plaster ring.
   3. Sectorizing baffles.

G. Diffuser models, sizes and finishes shall be as shown on the plans and/or as scheduled. Unless noted otherwise, diffusers shall have a baked enamel finish with color to be selected by the Architect.

2.05 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Blank-off unused portion of linear diffusers and grilles.

E. Coordinate border and frame type with Architectural Plans.

F. For return grilles open to a ceiling plenum provide insulated sound boot behind grille for sound control and to prevent above ceiling utilities from being visible from the occupied space.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 234100

AIR FILTERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes factory-fabricated air-filter devices and media used to remove particulate matter from air for HVAC applications.

1.03 DEFINITIONS

A. MERV: Minimum Efficiency Reporting Value per ASHRAE 52.2

B. Efficiency: Dust Spot Efficiency per ASHRAE 52.1.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions; operating characteristics; required clearances and access; rated flow capacity, including initial and final pressure drop at rated airflow; efficiency and test method; fire classification; furnished specialties; and accessories for each model indicated.

B. Shop Drawings: For air filters. Include plans, elevations, sections, details, and attachments to other work.
   1. Show filter rack assembly, dimensions, materials, and methods of assembly of components.
   2. Include setting drawings, templates, and requirements for installing anchor bolts and anchorages.
   3. Wiring Diagrams: For power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of filter and rack to include in operation and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Provide one complete sets of filters for each filter bank. If system includes pre-filters, provide only pre-filters.
   2. For filters 65% or MERV-11 and lower, provide enough filters for a minimum three filter changes shall be provided for each unit, filter unit, and fan coil unit. Media used during construction shall be replaced as required when static pressure drop as scheduled is exceeded, and when system is air balanced. The final set of media not used shall be turned over to the Owner as a spare.
   3. For filters –70% or MERV 12 and higher including HEPA filters, provide one (1) extra set of filters for each filtration unit changing prior to building opening. Provide both pre-filters and final filters replacement.

1.07 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Electronic Air Cleaners: Comply with ARI 850.

C. Comply with applicable requirements in ASHRAE 62.1.

D. Comply with ASHRAE 52.1 and ASHRAE 52.2 for method of testing and rating air-filter units.

E. Comply with NFPA 70 for installing electrical components.

F. Comply with NFPA 90A and NFPA 90B.

1.08 DELIVERY, STORAGE AND HANDLING

A. Protect filters, housings, accessories and finishes from damage during shipping, storage, handling and installation. Deliver materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. The Contractor shall provide for storage in an enclosed trailer, when stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic.

C. Materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional cost to the owner.

1.09 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.

1.10 DESIGN CRITERIA

A. Holding frames or housings specified in this Section may be furnished by the filter manufacturers listed below, or where applicable, as part of the factory packaged air handling units.

B. Filter holding frames shall accept Manufacturer's standard filter sizes. Systems which utilize custom size filters will not be acceptable.

C. Filter holding frame gaskets suitable for type filters utilized to control bypass of unfiltered air.

D. Refer to schedules on the drawings for specific filter applications, efficiencies, capacities and characteristics.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Description: Factory-fabricated, media type filters and filter housings.

B. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. AAF International.
   2. Camfil Farr.
   3. Flanders/CSC Corp.
   4. Tri-Dim Filter Corporation.
   5. Purafil, Inc.

C. Refer to individual product sections for additional specific manufacturers.

2.02 MEDIUM EFFICIENCY PLEATED FILTERS

A. Description: 30% dust spot efficiency, factory-fabricated, self –supported, extended-surface, pleated, panel-type, UL 900 listed disposable air filter with holding frames.

B. Media: Interlaced cotton and synthetic fibers with nonflammable adhesive and anti-microbial agent application.
   1. Separators shall be bonded to the media to maintain pleat configuration.
   2. Welded wire grid treated for corrosion resistance on 1" centers bonded to media on downstream side to maintain pleats.

3. Media bonded to frame to prevent air bypass.

C. Frame: Rigid, high wet-strength cardboard frame with diagonal support members bonded to air entering and air leaving side of pleats to maintain pleat spacing. .

D. Filters shall be 1", 2" or 4" thick MERV 7 or MERV 8 as scheduled.

E. Filters selected for a clean pressure drop less than 0.15", unless scheduled otherwise.

F. 2" and 4" thick filters, clean pressure drop not to exceed .31" at 500 fpm. Maximum air velocity rating of 600 fpm.

G. 1" thick filters, clean pressure drop not to exceed .25" at 350 fpm. Maximum air velocity rating of 425 fpm.

H. Rated to withstand a differential pressure up to 2.0" WG.

2.03 FILTER BACK GRILLES

A. Designed to accommodate manufacturer's standard catalog size filters, 1 inch thick, 30% medium efficient pleated air filters as specified. Unless indicated otherwise, grilles to be aluminum with core of fixed blades, hinged filter access and frame type appropriate to the installation. Refer to Diffuser, register and grilles specifications for additional requirements.

B. Designed for low face velocity of less than 250 FPM at an initial pressure drop of less than .15" W.C.

2.04 FILTER GAGES

A. Description: Diaphragm type air pressure differential gage with pointer, adjustable signal flag, over pressure relief and zero adjustment.
   1. Housing: Die cast aluminum case and bezel with acrylic cover.
   2. Size: 4" (102 mm) dial face.
   3. Range:
      a. Pre-filters and less than MERV 9 0- to 1.0-inch wg
      b. MERV 9 and above including Final Filters and HEPA Filters 0- to 2.0-inch wg.
   4. Accuracy: Plus or minus 3 percent of full scale.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product Dwyer Instruments, Inc. Series 2000 Magnehelic or comparable product by one of the following:
   1. Airguard Industries, Inc.

C. Accessories: Air filter kit with static-pressure tips, ¼" O.D. aluminum tubing, gage connections, vent valves, mounting bracket and weatherproof enclosure for exterior applications. Provide flush mounting kit when indicated on drawings.

D. Provide one gage for each filter bank.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Inspect areas where material is to be installed. Notify the Architect of conditions which would adversely affect the installation or subsequent utilization of filters. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Install filters and filter housings at locations indicated and/or specified according to manufacturer's written instructions.

B. Position each filter housing with clearance for normal service and maintenance.

C. Install filters in position to prevent passage of unfiltered air.

D. Provide separate filter gage for each pre-filter, high efficiency filter, HEPA filter and for pre-filters installed in factory air handling equipment.

E. Install filter gage static-pressure tips upstream and downstream from filters to measure pressure drop through filter. Mount filter gages on outside of filter housing or filter plenum in an accessible position. Adjust, level and calibrate gages.

F. Coordinate filter and filter housing installations with ductwork, equipment, controls and associated work.

G. Mark each filter gauge with dirty filter mark and set signal flag to inform maintenance personnel when to change filters.

H. Do not operate systems with HEPA filtration until construction activities generating dust, fumes and debris are completed and site is in a clean condition.

I. Install filter media upon installation of equipment. Upon start up of systems, Contractor shall monitor filter pressure loss and replace media as required for the duration of construction.

J. Filter Back Grilles: Upon completion of grille installation install filter. Undersized grilles shall be replaced to accept standard size filters. Oversized grilles shall have sheet metal filler strips installed to accept standard size filters.

3.03 CLEANING

A. After completing system installation and testing, adjusting, and balancing air-handling and air-distribution systems, clean filter housings and install new filter media.

END OF SECTION

SECTION 236200

PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes packaged, refrigerant compressor and condenser units.

B. Related Sections include the following:
   1. Division 23 Section "Seismic Restraint For HVAC Piping and Equipment" for requirements necessary for compliance with seismic criteria

1.03 ACTION SUBMITTALS

A. Product Data: For each compressor and condenser unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressor and condenser units to include in operation and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

1.07 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-In-Place Concrete" and Section 033053 "Miscellaneous Cast-In-Place Concrete."

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

C. Coordinate location of piping and electrical rough-ins.

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.
   1. Failures include the following:
      a. Compressor failure.
   2. Warranty Period (Compressor Only): Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
   1. Carrier Corporation; Commercial HVAC Systems.
   2. Johnson Controls, Inc.
   3. Trane

B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.
   1. Motor: Single and Two speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.

D. Refrigerant: R-407C R-410A R-410A or as scheduled.

E. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.

F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection and ball bearings.

G. Accessories:
   1. Coastal Filter: Mesh screen to protect condenser coil from salt damage.
   2. Crankcase heater.
   3. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
   4. Low-voltage thermostat and subbase and subbase to control compressor and condenser unit and evaporator fan.
   5. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
   6. Filter-dryer.
   7. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
   8. Liquid-line solenoid.
   9. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
   10. PE mounting base.
   11. Precharged and insulated suction and liquid tubing.
   12. Sound Hood: Wraps around sound attenuation cover for compressor.
   13. Thermostatic expansion valve.
   14. Time-Delay Relay: Continues operation of evaporator fan after compressor shuts off.

H. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

2.02 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 6 TO 120 TONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; Commercial HVAC Systems.
   2. Johnson Controls, Inc.
   3. Trane

B. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and backseating service access valves on suction and discharge ports.
   1. Capacity Control: On-off compressor cycling.

C. Refrigerant: R-407C R-410A R-134a or as scheduled.

D. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and backseating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

E. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:
   1. Permanently lubricated, ball-bearing totally enclosed motors.
   2. Separate motor for each fan.
   3. Dynamically and statically balanced fan assemblies.

F. Operating and safety controls include the following:
   1. Manual-reset, high-pressure cutout switches.
   2. Automatic-reset, low-pressure cutout switches.
   3. Low-oil-pressure cutout switch.
   4. Compressor-winding thermostat cutout switch.
   5. Three-leg, compressor-overload protection.
   6. Control transformer.
   7. Magnetic contactors for compressor and condenser fan motors.
   8. Timer to prevent excessive compressor cycling.

G. Accessories:
   1. Gage Panel: Package with refrigerant circuit suction and discharge gages.
   2. Part-winding-start timing relay, circuit breakers, and contactors.

H. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:
   1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
   2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
   3. Gasketed control panel door.
   4. Condenser coil hail guard.

2.03 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.04 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate compressor and condenser units according to ARI 206/110.

B. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."

C. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of compressor and condenser units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated; maintain manufacturer's recommended clearances.

B. Comply with mounting and anchoring requirements for seismic installations.

C. Install compressor and condenser units on PE mounting base.

D. Install compressor and condenser units on concrete base. Concrete materials and installation requirements are specified in Section 033000 "Cast-In-Place Concrete" and Section 033053 "Miscellaneous Cast-In-Place Concrete."

E. Install roof-mounting units on equipment supports specified in Section 077200 "Roof Accessories."

F. Maintain manufacturer's recommended clearances for service and maintenance.

G. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.03 CONNECTIONS

A. Comply with requirements for piping in other Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

C. Connect precharged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

D. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
   2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
      a. Inspect for physical damage to unit casing.
      b. Verify that access doors move freely and are weathertight.
      c. Clean units and inspect for construction debris.
      d. Verify that all bolts and screws are tight.
      e. Adjust vibration isolation and flexible connections.
      f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

E. Measure and record airflow and air temperature rise over coils.

F. Verify proper operation of condenser capacity control device.

G. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

H. After startup and performance test, lubricate bearings.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

END OF SECTION

SECTION 238126

SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

B. Related Sections include:
   1. Division 23 Section "Seismic Restraint for HVAC".
   2. Division 23 Section “Common Motor Requirements for HVAC Equipment”.
   3. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”.
   4. Division 23 Section “Vibration Controls for HVAC”.
   5. Division 23 Section “Control Sequence”.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Split System Air Conditioning units, components and mounting assemblies shall withstand the effects of seismic forces in accord with project Seismic specifications.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Fan curves shall include a series of curves indicating the relationship of CFM and static pressure for various RPM. Brake horsepower curves shall also be included. Indicate the design operating point clearly on the fan curves. Indicate fan brake horsepower requirement at the design operating point.

D. Product data of filter media, filter performance data, filter assembly, and filter frames shall be provided

E. Wiring Diagrams: For power, signal, and control wiring.

F. Samples for Initial Selection: For units with factory-applied color finishes.

1.05 INFORMATIONAL SUBMITTALS

A. Wind compliance: Contractor’s certification of compliance with wind structural loading requirements of the Building Code, wind loads identified in “Performance Requirement” article and Authority Having Jurisdiction. Submit as applicable:
   1. Product Approval: Equipment specific documentation indicating compliance.
   2. Delegated Design: Signed and sealed documents by registered engineer.
   3. Dimensioned Outline Drawings of Equipment: Identify maximum rated wind force in pounds per square foot, mounting and anchorage provisions.

4. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7. Submit ASCE7 special seismic certification as required. Include method used to determine compliance with requirements.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in operation and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set for each indoor unit.
   2. Fan Belts: One set for each belt-driven unit fan

1.08 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.09 DESIGN CRITERIA

A. The air conditioning equipment Condensing Unit shall be specifically designed for mounting in an outdoor application: curb or pedestal mounting as indicated on the drawings. The Split System Air Conditioning equipment and attachments to structure shall be designed to conform with the wind and seismic structural loading requirements identified in "Performance Requirement".

B. All electrical components to be UL Listed.

C. Total unit to be UL listed.

D. All materials to meet requirements of NFPA 90A.

E. Units shall have the configuration as indicated on the plans and/or as scheduled.

F. Fan coil unit shall meet or exceed the scheduled cooling and heating capacity, selected and rated in accordance with ARI 410.

G. Units shall not be selected at high fan speed unless noted otherwise.

H. Fan coil units shall be provided with all necessary tags and decals to aid in the service and/or indicate caution areas. Electrical wiring diagrams shall be attached to the control panel access door. Lifting lugs shall be supplied to facilitate rigging of the air-handling unit.

I. Condensing unit and air handling unit shall be of same manufacturer. Units shall be factory run tested to check cooling and heating operation, defrost initiation and termination, fan and blower rotation and control sequence. Units shall be designed to operate at ambient temperatures between 120 degrees F and 30 degrees F on cooling mode and 70 degrees F and 0 degrees F on heating mode. Cooling and heating capabilities shall be rated in accordance with ARI standards.

1.10 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 07 Section "Roof Accessories."

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Air Conditioning; Div. of Carrier Corporation.
   2. Mitsubishi
   3. Daikin
   4. LG
   5. Trane Company (The); Unitary Products Group.
   6. York International Corp.
   7. Panasonic (Panasonic Corporation of North America)

2.02 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
   1. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   2. Drain Pan and Drain Connection: Comply with ASHRAE 62.1.

B. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.

C. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Special Motor Features: Multitapped, multispeed with internal thermal protection and permanent lubrication.

D. Filters: Permanent, cleanable.

2.03 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Zinc phosphatized steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing. Make all components suitable for outdoor mounting.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation and sound attenuating compartment within the chassis. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
   1. Compressor Type: Hermetic or semi-hermetic.
   2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
   3. Refrigerant: R-407C, R-410A or as scheduled.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler and liquid accumulator. Pressure test at 245 psig minimum under water.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor, with safety guard for each fan.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 45 deg F.

H. Mounting Base: Polyethylene.

I. Controls to be factory wired and located in a separate enclosure.
   1. Controls to include a control power transformer for 120 volt, 60 hertz, single phase, fusing, magnetic contactors for compressor and condenser motors, compressor overload protection, high and low pressure switches, differential oil pressure control, non-cycling pump down if required and reset relay, refrigerant discharge and suction pressure gauges, and oil pressure gauge.
   2. Furnish a positive acting timer to prevent short cycling of compressor if power is interrupted. Timer shall prevent compressor form restarting for approximately 5 minutes after shutoff.

J. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

K. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."

2.04 ACCESSORIES

A. Control equipment and sequence of operation are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Defrost Control
   1. An outdoor coil defrost system shall be provided to prevent frost accumulation during heating cycle.
   2. The defrost system shall activate the reverse cycle defrost strictly on a demand basis to eliminated unnecessary defrost cycling.
   3. The defrost system shall have an integral time override to limit defrost cycle to a maximum of 5 minutes.

E. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

1. Minimum Insulation Thickness: 1 inch thick.

2.05 REFRIGERANT CIRCUIT

A. Each unit to have expansion valves, liquid receiver, filter driers and sightglass/moisture indicator. For Heat Pumps, provide heavy- duty, high capacity, pilot-operated reversing valves for automatic refrigerant cycle changeover.

B. All fittings to be ACR type. All sweat-type fittings to be wrought copper or forged brass. All elbows and return bends to be of the long radius type. Flare fittings to be of the frostproof type and constructed of forged brass.

C. Refrigeration Valves:
   1. Check valves 7/8" O.D. and smaller: Henry, Mueller, Superior, equal to Henry type #120 spring loaded piston check valves with accessible internal parts. Valve shall be provided with soft teflon seat, piston guide, stainless steel spring, 250 degrees F., 500 psig.
   2. Pressure Relief valves: Henry type #522, #52, #524, #523, #541, #542, #545, ASME approved pressure relief valves.
   3. Expansion valves: Alco, Sporlan, A.P., or equal. Unless specified otherwise, use externally equalized thermostatic expansion valves with superheat adjustment. Standard ratings to be in accordance with A.R.I. Standard 750-76.
   4. Liquid line solenoid valves: Alco, Sporlan, or approved equal. A.C.R. type valves to be U.L. listed.
   5. Hot gas bypass valves: Sporlan, Alco, Flo-Con or equal, electrically pilot operated. Unless specified otherwise, each valve shall be selected to maintain each system's minimum evaporating pressure. Multiple expansion valve, mixing tee, and any additional accessories required for proper system performance. All valves shall be UL listed.

D. Specialties:
   1. Liquid driers 5/8" O.D. or smaller: Throwaway or replaceable core type. ARI Standard 710, UL listed.
   2. Combination moisture and liquid indicators (sight glass): Sporlan, Superior, Alco, Henry, or equal, temperature compensating indicators, UL listed, 500 psig maximum working pressure.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Compliance: In accordance with approved submittals and manufacturer’s written installation instructions.

B. Secure equipment and mounting assemblies to structure with positive attachments in accordance project’s seismic loading requirements.

C. Secure exterior condensing unit and mounting assemblies to structure with positive attachments in accordance with project’s seismic and/or wind loading requirements.

D. Install units level and plumb.

E. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

F. Install ground-mounting, compressor-condenser components on 6-inch-thick, reinforced concrete base; 6 inches larger on each side than unit.

G. Install roof-mounting compressor-condenser components on equipment supports.

H. Comply with mounting and anchoring requirements for seismic installations.

I. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

J. Mount units at proper height above floor or ceiling so that proper trap depth is provided in the condensate drain line.

K. Install secondary auxiliary drain pans for all units located above ceilings or at other locations where building damage may occur from main drain pan overflow. Pipe auxiliary pan to nearest approved drain.

L. Mount thermostats at 4'-0" above finished floor unless otherwise noted.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. Refrigerant Piping: Manufactured soldered ACR type fittings are preferred and shall be used wherever practical. The use of sliding block or lever type tube bending tools or flaring block or punch type swaging tools to field fabricate elbow or coupling type fittings will be allowed on piping 1-1/8" O.D. and smaller as long as the fittings are of the long radius type and are free from buckling or kinks. Field fabricated mitered elbows and tees will not be allowed.

F. Valves in General:
   1. Liquid line driers shall be of the filter drier type, and of the size recommended by the manufacturer. Drier cartridges shall not be installed until the second evacuation has been completed.
   2. Install all valves per the manufacturer's instructions.
   3. When brazing any valve to connecting piping, protect the valve properly against damage from excessive heating. For minimum protection, wrap a damp cloth around the valve body or remove internal valve parts before brazing and direct the flame away from the valve body.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing. Notify Architect/Engineer 24 hours in advance of any test so Owner and/or Engineer may be present for the test if desired.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
      a. When the refrigeration connections have been completed, test the system at a minimum of 300 psig with the compressor suction and discharge valves closed, and all other valves in the system open. (If local codes require higher test pressures, such codes must be complied with). Sufficient liquid refrigerant shall be charged into the system to raise pressure to 35 psig, and dry nitrogen added to obtain the desired test pressure. Wrap all joints with a rubber or rawhide mallet and check for leaks with an electric leak detector having a certified sensitivity of at least one once per year.
      b. Refrigeration piping will not be acceptable unless it is gas tight. If any leaks are found, isolate the defective area, discharge the gas and repair the leaks, and then repeat the test. When testing has been completed, release all pressure freely to the atmosphere.
      c. The system shall be evacuated with a vacuum duty pump specifically manufactured for refrigeration vacuum duty, having a capability of pulling a vacuum of at least 50 microns.

Evacuation of the system must not be done by using refrigeration compressor. The pump should be connected to both the low and high side evacuation valves with copper tube or high vacuum hoses (1/4" I.D. minimum). The compressor service valves should remain closed. A high vacuum gauge capable of registering pressure in microns should be attached to the system for pressure reading. Hermetic or accessible- hermetic motor compressors must not be operated during evacuation because of the reduced dielectric strength of the atmosphere within the motor chamber. The check system pressure, a hand valve must be provided between the pressure gauge and the vacuum pump which can be closed to isolate the system and check the pressure.

d. Charge refrigerant directly from the original drums through a combination filter drier. Each drier may be used for a maximum of three cylinders of refrigerant, and then must be replaced with a fresh drier.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 238216

AIR COILS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following types of air coils that are stand-alone or an integral part of air-handling units:
   1. Hot-water.
   2. Refrigerant.

B. Related Sections include the following:
   1. Division 23 Sections for air-handling units.

1.03 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 air coil. Include rated capacity and pressure drop for each air coil.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

B. Field quality-control test reports.

1.05 CLOSEOUT SUBMITTALS

1. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

PART 2 - PRODUCTS

2.01 WATER COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Aerofin Corporation.
   2. Carrier Corporation.
   3. Coil Company, LLC.
   4. Dunham-Bush, Inc.
   5. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
   6. Trane.
   7. USA Coil & Air.

8. York

B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 250 psig, 300 deg F.

D. Source Quality Control: Factory tested to 300 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.

F. Fins: Aluminum, minimum 0.006 inch thick.

G. Headers: Seamless copper tube with brazed joints, prime coated.

H. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch (1.6 mm) thick for flanged mounting.

I. Hot-Water Coil Characteristics:
1. Minimum Fin Spacing: 0.083 inch.

2.02 REFRIGERANT COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aerofin Corporation.
2. Carrier Corporation.
3. Coil Company, LLC.
4. Dunham-Bush, Inc.
5. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
6. Lennox Industries Inc.
7. Trane.
8. USA Coil & Air.
9. York

B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.

C. Minimum Working-Pressure Rating: 300 psig.

D. Source Quality Control: Factory tested to 450 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick

F. Fins: Aluminum, minimum 0.006 inch thick.

G. Coil Split: Interlaced or Row Split.

H. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.

I. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch (1.6 mm) thick for flanged mounting.

J. Capacities and Characteristics:
1. Minimum Fin Spacing: 0.083 inch.

2.03 WEATHER INHIBITOR COIL COATING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AST.
2. Bronz-Glow.
3. Husky.
4. Modine ElectroFin E-Coat

B. The following coils shall be dipped with a weather inhibitor coating. Treatment shall be provided with certificate of coating specification and a 60 month written warranty.
   1. Refrigerant

C. Application: The coil shall be coated by the coating provider at their facility. Field application is not acceptable.

D. The coating system shall have less than 1% effect on heat exchange efficiency. The coating system shall be flexible enough (400% elongation) to allow bending of the fins 12 or more times, at an angle greater than 180 degrees to their normal position without showing signs of fissure or stress cracking, peeling or flaking of the coating. The coating shall not chip, crack or flake due to repeated deformation of the fins. It is essential that the coating be applied uniformly over the finned coil surface.

E. The coating system must function from a minimum temperature of -30 degrees F. to 225 degrees F. The coating shall not support combustion (burn without continual application of external flame source).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install coils level and plumb.

B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Install stainless-steel drain pan under each cooling coil and under each coil located over electrical equipment or in IT/Communications rooms.
   1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
   2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
   3. Extend drain pan upstream and downstream from coil face.
   4. Extend drain pan under coil headers and exposed supply piping.

D. Straighten bent fins on air coils.

E. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Provide air vent and drain valve at each coil.

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION

SECTION 238219

FAN COIL UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Blower coil units and accessories.

B. Related Sections include the following:
   1. Division 23 Section "Seismic Restraint For HVAC Piping and Equipment" for requirements necessary for compliance with seismic criteria
   2. Division 23 Section “General Duty Valves for Hydronic Piping for requirements for piping appurtenances including balancing valves and hook-up kits.

1.03 DEFINITIONS

A. BAS: Building automation system.

1.04 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, accessories, dimensions, weights, required clearances and location and size of each field connection.

1.05 INFORMATIONAL SUBMITTALS

A. Seismic Qualification: Manufacturer’s certification of seismic qualification according to ASCE 7-05. Submit ASCE 7-05 special seismic certification as required. Include method used to determine compliance with requirements.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan-coil units to include in operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: Furnish one spare filter for each filter installed.
   2. Fan Belts: Furnish one spare fan belt for each belt-driven unit installed

1.08 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.09 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.02 BLOWER COIL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carrier Corporation; a UTC company.
   2. Daikin Applied
   3. ENVIRO-TEC; by Johnson Controls, Inc.
   4. Greenheck Fan Corporation.
   5. IEC; a subsidiary of LSB Industries, Inc.
   6. Nailor Industries, Inc.
   7. Price.
   8. Titus.
   9. Trane Inc.

B. Coil Section Insulation: 1-inch-thick, foil-faced glass fiber or matte-finish, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. All exposed seams shall be sealed to prevent fibers from reaching the airstream.
   1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
   2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Main and Auxiliary Drain Pans: Plastic, Stainless steel or Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1.
   1. Separate auxiliary drain connection on same side as main connection.

D. Casing: Unfinished heavy-gauge galvanized steel
   1. Fan housing sides directly attached to top and bottom panels to strengthen unit.
   2. Coil access panels: Located on both sides of unit to allow for easy removal of internal coils and drain pan.
   3. Main access panels: Located on both sides of unit for easy access to fan, motor and drive.
   4. Duct collars: Provide at supply and return duct openings at unit. For unducted applications, provide ½”x ½” wiremesh aluminum screen to protect opening.
   5. Ducted applications: Provide return opening with mixing box or full sized plenum for connection of return and outdoor air ducts.

6. Dampers: For mixing box, galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

E. Filter rack: Standard filter rack. Filter rack configuration shall provide maximum 500 fpm at nominal airflow. Provide angled filter rack if required.

F. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
   1. MERV Rating: 8 minimum when tested according to ASHRAE 52.2.

G. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and brazed joints at fittings. Comply with AHRI 210/240, and leak test to minimum 450 psig for a minimum 300-psig working pressure. Include thermal expansion valve

H. Fans: Double width, forward curved, centrifugal. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls. Direct Drive.

I. Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
   1. Permanently lubricated, multispeed motor resiliently mounted in the fan inlet.
   2. Variable Speed applications: Electronic commutation type (EC Motor)

J. Remote condensing units are specified in Section 236200 "Packaged Compressor and Condenser Units."

K. Control devices and operational sequences are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Control Sequence." Provide DDC Terminal Controller by fan coil or BAS system manufacturer.

L. Basic Unit Controls:
   1. Control voltage transformer.
   2. Remote-mounted thermostat with the following features:
      a. Heat-cool-off switch.
      b. Fan on-auto switch.
      c. Fan-speed switch where multispeed motors are indicated.
      d. Manual changeover.
      e. Adjustable deadband.
      f. Exposed set point.
      g. Exposed indication.
      h. Degree F indication.
   3. Data entry and access port.
      a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
      b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status

M. BAS Interface Requirements:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation.
   3. Provide BACnet or LonWorks compatible interface for central BAS workstation for the following functions:
      a. Adjust set points.
      b. Blower-coil-unit start, stop, and operating status.
      c. Data inquiry, including outdoor-air damper position, supply- and room-air temperature and humidity.
      d. Occupied and unoccupied schedules

N. Electrical Connection: Factory wire motors, components and controls for a single electrical connection. Provide factory mounted, integral non-fused incoming line side disconnect. Fuses shall be listed as branch circuit protection.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Comply with mounting and anchoring requirements for seismic installations.

B. Install units level and plumb.

C. Install units to comply with NFPA 90A.

D. Suspend units from structure where indicated.. Vibration isolators are specified in Division 23 Section "Vibration Controls for HVAC Piping and Equipment."

E. Install secondary auxiliary drain pans for all units.

F. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor unless architect specifies otherwise.

G. Install new filters in each unit within two weeks after Substantial Completion.

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install piping adjacent to machine to allow service and maintenance.
   2. Connect piping to unit factory hydronic piping package. Install piping package if shipped loose.
   3. Connect condensate drain to nearest approved drain.
      a. Install minimum 2”condensate trap. Install cleanouts in piping at changes of direction.

B. Connect supply and return ducts to ducted units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.

3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.05 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 260500

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Electrical equipment coordination and installation.
   2. Access Panels
   3. Common electrical installation requirements.

1.03 DEFINITIONS

A. Code. National, State and Local Electrical codes including OSHA requirements.

B. 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.

C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

D. Electrical ductbank: Assembly consisting of multiple electrical conduits embedded in earth or concrete.

E. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

F. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

G. 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.

H. High voltage: 35,001 volts and greater.

I. Home Run: The portion of a branch circuit between the serving panelboard and the first electrical outlet, lighting fixture, or other electrical load connected to the circuit.

J. Low voltage: 50 to 600 volts.

K. Medium voltage: 601 to 35,000 volts.

L. Provide. Furnish, install and wire ready for service.

M. Signal voltage. NEC class 1, 2, or 3 remote control, signaling, or power limited circuits.

1.04 SCOPE

A. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work may not be specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

B. It is the intent that these Specifications and associated Drawings establish minimum requirements for products and equipment with the intent to provide electrical service, distribution and systems

finished, tested and ready for operation. Incidental detail that is not shown or specified, but necessary for proper installation and operation shall be included in the work and in these Contractor's estimates, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each raceway and piece of equipment to minimize conflicts with other trades.

C. This project will be phased, as defined by the Owner. This may necessitate the provision of temporary electrical utilities. All associated appurtenances with the utilities shall be provided as part of this project.

D. Information and components shown on riser diagrams but not shown on plans, and vice versa, shall be provided as if expressly required on both.

E. It is the requirement of these Contract Documents to have the contractors provide systems and components that are fully complete, operational and suitable for the intended use. There may be situations in the documents were insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the Contractor has failed to notify the Architect of the situation in accordance with Paragraph (A) above, the Contractor shall include in their bid the specific components or subsystems with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

1.05 MODIFICATIONS IN LAYOUT

A. Drawings are intended to outline the scope of work required and are not intended to be installation drawings. Drawings are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component nor do they show the exact routings. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational, nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet Architectural requirements.

B. Unless specifically stated to the contrary, no measurement of an electric drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the electric drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

C. Prior to installation of visible material and equipment (including access panels) in finished spaces, review Architectural Drawings for desired locations and where not definitely indicated, request information from Architect.

D. Check Contract Documents, as well as, Submittals and Shop Drawings of all subcontractors to verify and coordinate spaces in which work of Divisions 21 through 28 will be installed.

E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades. Systems shall be run parallel with or perpendicular to major architectural and structural building elements.

F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Architect for review and approval.

1.06 COORDINATION

A. Coordinate arrangement, mounting, and support of equipment and raceways:

1. To maintain maximum headroom; all piping, duct, conduit and associated components to be as tight as possible to underside of structure to provide for ease of disconnecting the equipment with minimum interference to other installations.
2. To allow right of way for piping installed at required slope.
3. To allow connecting raceways, cables, wireways, cable trays, and busways to 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."

1.07 COORDINATION DRAWINGS

A. When included as part of the Contract Documents, there shall be full cooperation and coordination of all specialty trades.

1.08 MAINTENANCE MANUALS AND OPERATING INSTRUCTIONS

A. Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in a coordinated manual using loose leaf sheets in a three ring binder(s). Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.
1. Copies of all approved submittals/shop drawings.
2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.
3. Startup and shutdown procedures.
4. Test records.
5. Wiring diagrams.
6. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment.
7. Owner's written acknowledgement of satisfactory completion of instruction period.

C. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

D. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions.

E. Submittal Procedure and Format
1. This Paragraph supplements Division 1.
2. Submittal Cover Sheet
   a. Submittal data for each product shall include a copy of the following cover sheet completely filled out. Incomplete or incorrect cover sheet submittal shall constitute reason for rejection.
   b. Shop drawings/submittals shall be submitted according to applicable specification section’s requirements with a separate cover sheet completed for each product, rather than one cover sheet for multiple products, whether or not supplied by one manufacturer or vendor.

SUBMITTAL COVER SHEET	
PROJECT:	CONTRACTOR:
DIVISION NO.:	SECTION NO.:
DESCRIPTION:	
CONTRACT DRAWING REFERENCE NO:	
EQUIPMENT TAG:	
SUBMISSION (CIRCLE ONE): FIRST, SECOND, THIRD, FOURTH	
DATE:	
INFORMATION AND CHECKLIST	

1.	Contractor's Log #ID			
2.	Name, address, and phone number of supplier.			
3.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes	No	
4.	Is this item a substitution?	Yes	No	
5.	Are deviations clearly identified?	Yes	No	
6.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
7.	Has support, erection, weights, and installation been coordinated with all trades?	Yes	No	
8.	Does the proposed installation void warranties and/or violate UL or code requirements?	Yes	No	
9.	Does this material/equipment add expense to any other trade or project costs?	Yes	No	
10.	Does equipment require interface with other trades? List divisions and specifics requiring coordination?	Yes	No	
11.	Is control interface coordinated?	Yes	No	
12.	List electrical characteristics (V/Ph/A)			

3. Multiple Re-submittals: The Engineer will review the first submittal from the contractor and respond with comments and will review one re-submittal for the same item(s) from the contractor and respond with comments. If the contractor is required to make subsequent submittals for the same item(s) the Engineer shall be compensated by the contractor for the time to review each subsequent re-submittal. The contractor shall agree to compensate the Engineer a minimum of $500 per each re-submittal item.
4. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be 1/4 inches = 1 foot 0 inch scale unless specified otherwise.
5. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.
6. Provide shop drawing submittals showing details of piping connections to ALL equipment. If connection details are not submitted and connections are found to be installed incorrectly in the field, this contractor shall reinstall them within the original contract price.
7. Shop drawings for different systems and equipment shall be bound separately by specification section as indicated above and not bound by manufacturer. Each separate submittal shall have its own transmittal and cover letter. Submittals which contain different specification section systems bound together shall be returned un-reviewed for re-submittal.
8. Lighting Fixture shop drawings shall consist of two submittals, one for interior lighting and one for exterior lighting. Each submittal shall have all associated light fixtures included. Separate submittals grouped by manufacturer or supplier shall not be accepted. The contractor shall be responsible for coordinating drawings from his various suppliers in order to comply with this requirement.

1.09 QUALITY ASSURANCE

A. Acceptable Manufacturers
   1. The Engineer’s design for each product is based on the manufacturer listed in the schedule or shown on the drawings. In Part 2 of some technical specifications, other manufacturers are listed as being acceptable. The listing of a manufacturer as acceptable does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. These are acceptable only if, as a minimum, they:
      a. Meet all performance criteria listed in the schedules and outlined in the specification.
      b. Have identical operating characteristics to those called for in the specification. For example, a two-stroke diesel generator will not be acceptable if a four-stroke model is specified.
      c. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer’s name appears as acceptable shall not be taken to mean that the Engineer has determined that the manufacturer’s products will fit within the available space - this determination is solely the responsibility of the contractor.
      d. Products must adhere to all architectural considerations including but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers, lighting and plumbing fixtures - being the same size and of the same physical appearance as scheduled or specified products.

B. All equipment shall be labeled or listed by the National Board of Underwriters Laboratories (U.L.) or other recognized listing/testing agency where such labeling or listing exists for such material.

C. All electrical components, devices and accessories shall be listed and labeled as defined in **the** California Electrical Code (CEC), by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Skid-mounted or packaged assemblies shall be listed and labeled as an assembly, not just the individual components.

1.10 UTILITY CHARGES

A. The contractor shall be responsible for costs from electric utility company that are assessed the Owner for the installation of the permanent electric service. It is the responsibility of the contractor to obtain those costs from the utility company and include them in their bid.

1.11 TEMPORARY CONSTRUCTION POWER

A. Provide temporary lighting and construction power for the project. Pay the usage charges to the serving utility for electric service associated with temporary lighting and power for construction.

B. Continuity of Utility Service:
   1. In the absence of specific requirements in Division 1, comply with the following procedures for shut-downs.
      a. Provide temporary services where project construction schedule requires extended shut downs of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shut downs are interruptions of existing services for a period of time longer than that acceptable to the Owner.
      b. Contractor shall coordinate any shutdowns of existing systems as follows:
      c. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days is required.
      d. Minimize timeline of shutdowns of any system.
      e. Provide temporary services where required and perform shutdowns and tie-ins at a time convenient to Owner.
   2. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
   3. Perform required survey and inspection work required by the notice for shutdown.
   4. All life safety systems shall be returned to service at the end of each work day, when work is being performed on the systems. It is the responsibility of the Contractor to provide all associated appurtenances necessary to ensure that the systems are in proper working condition at all times.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment/materials from damage during shipping, storage, handling and installation. Delivery equipment/materials to the site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. The Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building “dry-in”, to prevent any damage resulting from inclement weather or construction traffic. Specialties shall not be stored outdoors.

C. Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional expense. Do not store equipment with PVC material with exposure to direct sunlight.

PART 2 - PRODUCTS

2.01 CEILING ACCESS AND ACCESS PANELS

A. Access panels are generally not shown on the drawings, but they are required to be provided by Contractor.

B. Access panels shall be of size required to provide adequate access to equipment. Minimum size shall be 12” X 12” for hand access or 24” X 24” for body access. Minimum 16 gauge frame, not less than 18 gauge hinged door panel. Door locks shall be screwdriver operated for panels in general location applications and shall be key locked for public area applications.

C. Furnish access panels for installation under other Sections valves or other items installed under this Division require access and are concealed in floor, wall, furred space or above ceiling. Access panels shall be by Milcor, Knapp, Nystorm or Inland Steel; coordinate selection with other Sections supplying similar access panels. Color of panel shall be selected by the Architect.

D. Panels shall include concealed hinges, cam type locking devices, and shall have a frame border type necessary for the particular wall or ceiling construction in which they are installed. Access panels shall be flush mounted, recessed frame type units. Access panels shall be prime coated steel, for field painting for general applications and stainless steel for use in toilet rooms, shower rooms, and similar wet locations.

E. Access panels shall have same fire rating classification as surface penetrated. Rated access panels must have U.L. Label.

PART 3 - EXECUTION

3.01 PRE-BID SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this division. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

C. The documentation of existing conditions was derived from As-Built documents and are in part unverified. Actual existing conditions shall be verified prior to commencement of work.

3.02 ELECTRICAL DEMOLITION

A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.

B. De-energize, disconnect, demolish, and remove electrical systems, equipment, raceways, wiring, and components indicated to be removed.
   1. Conduit to Be Removed: Remove portion of piping indicated or specified to be removed. In general, all empty raceways and associated supporting devices shall be removed back to nearest active junction box, panelboard, switchboard, panel cabinet, or other similar enclosure.
   2. Conductors to be Removed: Unless specifically stated elsewhere, all un-terminated conductors shall be de-energized, and all de-energized conductors shall be removed. Un-terminated conductors shall not be provided with wire nut covers nor provided with electrical tape covering exposed ends.
   3. Equipment to Be Removed: De-energize, disconnect associated raceways and wiring, and remove equipment.
   4. Equipment to Be Removed and Reinstalled: De-energize, disconnect associated raceways and wiring, and remove equipment. Clean equipment and store where appropriate, reinstall, reconnect, and make equipment operational. Test equipment and associated components in accordance with the appropriate specification section.

5. Equipment to Be Removed and Salvaged: De-energize, disconnect associated raceways and wiring, and move equipment to on site storage area as designated by the Owner.
6. Any unused conduit openings in junction boxes, panelboards, switchboards, panel cabinets, pull boxes, or other similar enclosures shall be covered in a code approved manner.
7. Update any electrical circuit directories or breaker identification nameplates to reflect changes in the status of overcurrent devices resulting from demolition.
8. Unless specifically noted otherwise, any equipment removed from service as part of project demolition becomes the property of the contractor who shall be responsible for its disposal.
9. Contractor shall check the ballasts of light fixtures removed from service. If any ballasts contain PCB's those ballasts shall be stored on site in containers and in a manner approved by local authorities and the Environmental Protection Agency. The contractor shall not be responsible for disposal of ballasts that contain PCB's

C. If equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

D. Notify Architect of location and extent of existing piping, conduit, OR equipment that interferes with new construction. In coordination with and with approval of Architect, relocate conduit and equipment to permit new work to be provided as required by Contract Documents. Remove non-functioning and abandoned conduit and equipment as directed by Architect. Dispose of or store items as requested by Architect.

3.03 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1 – Standard Practices for Good Workmanship in Electrical Contracting.

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.

F. 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."

3.04 CONCRETE PADS

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.

D. Provide raised concrete pads for all floor mounted electrical equipment, including but not limited to, switchboards, transformers, motor control centers, transfer switches, lighting control/dimmer cabinets, and motor controllers.

3.05 FIREPROOFING:

A. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.

B. Piping and other items which would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.

C. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

3.06 INSTALLATION ONLY ITEMS:

A. Where this contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This contractor shall be responsible for:
   1. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
   2. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

B. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

3.07 PAINTING

A. Furnish one can of aerosol-free touch-up paint for each different color factory finish which is to be the final finished surface of the product.

3.08 RECORD DOCUMENTS

A. Record Drawings are specified in Division 01 Section "Project Record Documents."

B. The Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing each feeder, pull box and protective device. Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner in both electronic and hard paper copy formats. Record drawings shall also include:
   1. Locations of buried conduit or similar items. Include buried depth.
   2. Field changes of dimension or detail.
   3. Changes made by field order or change order.
   4. Details not on original contract drawings.
   5. Changes to circuit numbers.
   6. Junction box locations and conduit runs, with trade sizes indicated, for lighting, power, and electrical systems installed.
   7. Final panel schedules on drawings matching construction document drawing size.

3.09 CLEANING

A. Cleaning shall be performed prior to equipment being energized.

B. Raceways

1. General:
    a. Cover all raceway openings prior to the installation of conductors to prevent dirt, moisture, and other debris from entering the raceways.
    b. Before pulling conductors, swab out all raceways to remove any debris that may have entered raceways during construction or during storage.
    c. When external surfaces of raceways or enclosures are rusted, clean and restore surfaces to original condition.
2. Equipment
    a. After completion of work but prior to turning equipment over to the Owner, clean the exterior surfaces to be free from concrete residue, dirt, paint residue, etc.
    b. All dirt, drywall dust, and all other foreign matter shall be blown from, wiped away, or vacuumed from transformer coils, terminal devices, panelboard interiors, switchboard interiors, junction boxes, pullboxes, and other similar equipment enclosures.
    c. Thoroughly clean equipment of all stains, paint spots, dirt, and dust. Remove all temporary labels not used for instruction or operation and remove all visible trade labels.

3.10 COMMISSIONING

A. The Commissioning Authority will be Owner furnished and under direct contract with the Owner. That is, the General Contractor and this subcontractor's bid price shall not include the services of the Commissioning Authority but shall include costs for coordination testing, Contractor commissioning, etc.

END OF SECTION

SECTION 260510

SELECTIVE ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:
   1. Disconnection of power to selected portions of building or structure.
   2. Demolition and removal of selected electrical components.

B. Related Requirements: Division 01 Section “Selective Structure Demolition” for sequencing and scheduling procedures and requirements for demolition activities.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Materials for patching and extending work: Compatible with existing electrical installations.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not rely solely on electrical drawings to determine extent of general construction demolition. Refer to architectural demolition plans for the exact extent of general construction demolition required by this contract.

B. Review available record documents of the existing construction. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Refer to demolition drawings of other trades. Where motors, control panels, and other loads that have an electrical connection are being removed, include the disconnection and removal of associated electrical feeds, circuits, and loose control equipment in this contract.

D. Survey existing conditions and correlate with requirements indicated to determine the extent of selective demolition required.

E. Verify circuiting arrangements are as shown on Drawings.

F. Verify that abandoned wiring and equipment serve only abandoned facilities.

G. Report discrepancies to Architect before disturbing existing installation.

H. Examine panelboards and distribution equipment affected by the work. Report deficiencies to Architect.

I. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

A. Protect existing work to remain in place, to be reused, or to remain property of Owner.

B. Protect existing services and utilities.

C. Disconnect electrical systems in walls floors and ceilings scheduled for removal.

D. Coordinate utility service outages with serving utility company.

E. Provide temporary wiring and connections to maintain existing circuits in service during construction.

F. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service to areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate, and extend existing installations as shown and to accommodate new construction.

B. Remove abandoned wiring to source of supply.

C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cap stubs flush with surrounding surfaces and patch to match color and texture.

D. Outlet boxes being abandoned in existing walls in remodeled areas shall have opening patched to match existing wall finish. Blank covers are not acceptable.

E. Disconnect and remove abandoned panelboards and distribution equipment.

F. Disconnect and remove abandoned luminaires. Remove brackets, stands, hangers, and other accessories.

G. Repair adjacent construction and finishes damage during demolition and extension work.

H. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

I. Maintain continuity of circuits that remain in service.

J. During the demolition and alterations, the fire alarm system, exit lighting and corridor life safety lighting shall remain active.

K. The fire alarm zone serving smoke detectors in the smoke compartment where work is occurring may be disconnected when work is taking place to avoid false alarms. Zone shall be reconnected at end of each workday. Smoke detectors shall be protected to keep dust and dirt from entering sensing chamber. All smoke detectors within the smoke compartment where work is occurring shall be cleaned upon completion of work within that area.

L. Existing conduit and wiring in remodeled area that is not being removed, but which will be in conflict with new HVAC duct work being installed, shall be rerouted as required.

M. This Contractor shall provide required additional support for existing conduit in remodeled area that is not being removed and is not properly supported in accordance with NEC requirements.

3.04 CLEANING AND REPAIR

A. Clean existing materials and equipment which remain or are to be reused. Report damage or defects to Architect

B. Existing Panelboards: Clean exposed surfaces and check tightness electrical connections. Provide closure plates for vacant positions. Provide type circuit directory showing revised circuiting arrangements.

C. Luminaires: Clean existing luminaires shown to be reused. Use mild detergent to clean interior surfaces and visible exterior surfaces; rinse with clean water and wipe dry. Replace lamps. Energize fixtures. Notify Architect of fixtures with faulty components.

END OF SECTION

SECTION 260513

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.03 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

1.05 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each cable and accessory type, signed by manufacturers.

B. Source quality-control test reports.

C. Field quality-control test reports.

1.06 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable. Cable splicer shall have a minimum of five years experience.

B. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the California Electrical Code (CEC), by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C2 and CEC.

1.07 PROJECT CONDITIONS

A. Store cables on reels on elevated platforms in a dry location.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Construction Manager and/or Owner no fewer than twenty-four hours in advance of proposed interruption of electric service.
   2. Indicate method of providing temporary electric service.
   3. Do not proceed with interruption of electric service without Construction Manager's and/or Owner's written permission.
   4. Comply with NFPA 70E.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cables:
      a. Kerite Co. (The); Hubbell Incorporated.
      b. Okonite Company (The).
      c. General Cable Technologies Corporation.
      d. Southwire Company.
   2. Cable Splicing and Terminating Products and Accessories:
      a. RTE Components; Cooper Power Systems, Inc.
      b. Thomas & Betts Corporation/Elastimold.
      c. 3M; Electrical Products Division.
      d. Raychem Corporation

2.02 CABLES

A. Cable Type: MV105.

B. Comply with UL 1072, AEIC CS 8 and ICEA S-93-639.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Conductor Shield: Extruded, semi-conducting, ethylene-propylene rubber (EPR) compound.

F. Conductor Insulation: EPR.
   1. Voltage Rating: **15**kV.
   2. Insulation Thickness: 133 percent insulation level.

G. Insulation Shield: Extruded, semi-conducting, EPR compound.

H. Metallic Shield: 5 mil copper tape, helically applied, with a 12-1/2% nominal overlap, over semiconducting insulation shield.

I. Cable Jacket: Black, sunlight-resistant PVC. Overall jacket for cable installed in tray shall be flame retardant PVC jacket in accordance with IEEE 1202, FT-4.

J. Cable Identification:
   1. Cables shall have embossed on the outer jacket information indicating name of the manufacturer, the year in which the cable was manufactured, size, material and a unique number for identification purposes. The information shall be closely grouped at 1-foot intervals.

2.03 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404. Submit cable manufacturer's recommended splice kit to engineer for approval before making splice. Splice kits that meet the cable manufacturer's recommendations may be used if approved by the engineer.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
   1. Pre-molded, cold-shrink-rubber, in-line splicing kit.

2.04 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.

2.05 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Tool Set: Shotgun hot stick with energized terminal indicator and carrying case.

2.06 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil- thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch wide.

2.07 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 before shipping.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cables according to IEEE 576.

B. Examine raceways to receive medium-voltage cables for compliance with installation tolerances and other conditions affecting performance of the cable. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. No work shall be done on energized circuits. Perform switching when required and authorized by the Construction Manager to remove a cable from service and isolate it from all possible sources of electrical supply.

D. Prior to pulling in any cable, check ducts by pulling a mandrel through each duct from manhole to manhole as the circuit run required. The mandrel shall have an outside diameter .37” less than the inside diameter of the duct and be at least 24” long.

E. If any serious defects are found in the duct banks and manholes, notify the Construction Manager's Representative. Do not proceed until the defects are corrected to the satisfaction of Contractor.

F. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
   1. Where necessary, use manufacturer-approved pulling compound or lubricant. The lubricant shall not have deleterious effects on the conduits or the physical or electrical properties of the cable insulation, semi-conducting or jacket materials. The lubricant and its residue shall not propagate flame. The lubricant shall be UL listed. The lubricant shall not contain waxes or greases.

2. Factory installed pull-eyes shall be employed for all pull operations. Use pulling means, including fish tape, cable and rope that will not damage cables and raceways. Do not use basket weave cable grips or rope hitches for pulling attachment to cable.

G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

H. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

I. Install "buried-cable" warning tape 12 inches above cables.

J. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

K. Conductors shall be continuous, without splices in so far as, practicable. All splices not specifically indicated on drawings must be prior approved by engineer in writing before splicing any cable.

L. Exercise care, while installing conductors, so as not to injure the insulation. Follow the manufacturer's recommendations for minimum bending radius and other installation practices.

M. Pull cables through pull boxes, ducts, or conduits in such a manner that the cables will not have too sharp a bend or be damaged by being pulled over a sharp edge or corner. Raceway entrances and exits shall have smooth edged end bells at all locations.

N. The pulling tension of the conductors shall be such that it will not damage the insulation. Pulling tension applied shall not exceed values recommended by the manufacturer.

O. Do not permit cable to chafe on the ground, manhole edges or any sharp surfaces during pulling. Provide timbers and flexible cable pulling tubes where necessary to guide and protect the cable.

P. Approved splices shall be made in junction boxes or manholes only; use standard kits.

Q. Install separable insulated connector components where indicated in accordance with manufacturer's written instructions.

R. Install terminations at ends of conductors and seal cable ends with standard kits.

S. Medium Voltage Bushing Inserts
   1. Bushing inserts for medium voltage devices such as transformer primaries and pad-mounted switches shall be provided by the contractor. Bushings shall be single type.
   2. Inserts shall be rated for the equipment served and shall meet the requirements of ANSI/IEEE standard 386. Inserts shall have a minimum 95 kV BIL rating.
   3. Bushings inserts shall be designed to directly screw onto the threads of the bushing well stud.

T. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. Arc-Proofing: Provide arc-proofing tape on all medium voltage cables in manholes and handholes. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
   1. Clean cable sheath.
   2. Wrap metallic cable components with 10-mil pipe-wrapping tape.
   3. Smooth surface contours with electrical insulation putty.
   4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
   5. Band arc-proofing tape with 1-inch- wide bands of half-lapped, adhesive, glass-cloth tape 2 inches o.c.

U. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping."

V. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

W. Identify cables according to Division 26 Section "Identification for Electrical Systems."

3.02 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   2. After installing medium-voltage cables and before electrical circuitry has been energized, test for compliance with requirements.

B. Remove and replace malfunctioning cable and retest as specified above.

END OF SECTION

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

1.03 ACTION SUBMITTALS

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

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the California Electric Code (CEC), Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with the CEC.

1.06 PROJECT CONDITIONS

A. Wire and cable routing where shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

B. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

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. Alcan Products Corporation; Alcan Cable Division.
   2. American Insulated Wire Corp.
   3. General Cable Corporation.
   4. Senator Wire & Cable Company.
   5. Southwire Company.

B. Aluminum and Copper Conductors: Comply with NEMA WC 70.

C. All aluminum conductors shall be American made and comprised of 8000 series aluminum alloy. 1350 EC grade aluminum is not allowed.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN/THWN, XHHW-2 and SO.

2.02 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:
   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.
6. Thomas & Betts.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Spring wire connectors: Corrosion-resistant, live-action spring in insulated shell, rated 105°C.

D. Connectors and lugs: Circumferential compression (non-indenter) type.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Where aluminum cable is used, contractor shall follow methodologies outlined in NECA/AA 104-2006.

B. Feeders:
1. Conductor: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Insulation: CEC: Type XHHW-2 insulation for feeders larger than #2 AWG; Type THHN/THWN insulation for feeders #2 AWG and smaller.

C. Branch Circuits:
1. Conductor: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
2. Stranded conductors to be Type B or C only.
3. Insulation: CEC: Type XHHW-2 insulation for branch circuits larger than #2 AWG; Type THHN/THWN insulation for branch circuits #2 AWG and smaller.

D. Motors and equipment connections subject to vibration: Copper. No. 12 AWG and larger, stranded conductor, single conductor.

E. Conductors for motors served by VFCs where conductors from VFC to motor are run in PVC conduit shall be Type XHHW-2, RHW-2 shielded equal to Belden Cat#295XX and as indicated on equipment schedules. Where conductors from VFC to motor are run in above grade metallic conduit, standard non-shielded conductors shall be allowed.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Single conductors in raceway.

B. Exposed Feeders: Single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Single conductors in raceway.

E. Feeders Installed below Raised Flooring: Single conductors in raceway.

F. Exposed Branch Circuits, Including in Crawlspaces: Single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Single conductors in raceway.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Single conductors in raceway.

I. Branch Circuits Installed below Raised Flooring: Single conductors in raceway.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. Class 1 Control Circuits: Single conductors in raceway.

L. Class 2 Control Circuits: Single conductors in raceway.

3.03 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.

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."

3.04 FEEDER REQUIREMENTS

A. Contractor shall provide lugs, compression fittings, auxiliary wireways, etc., of adequate size for termination of feeder sizes as indicated on drawings. Feeder sizes indicated may be oversized for voltage drop in some cases. Contractor shall coordinate with equipment manufacturer for proper lug sizes.

B. Extend feeders at full capacity from origin to termination.

C. Each conduit raceway shall contain only those conductors constituting a single feeder circuit.

D. Where multiple raceways are used for a single feeder, each raceway shall contain a conductor of each phase and neutral, if used, and a grounding conductor.

E. Where feeder conductors are run in parallel, conductors shall be of same length, same material, circular-mil area, insulation type, and terminated in same manner.

F. Where parallel feeder conductors are run in separate raceways, raceways shall have same physical characteristics.

G. Feeders shall follow most accessible routes, concealed in construction in finished areas, exposed to the minimum temperature gradient and to minimum temperature fluctuation.

H. Confine feeders to insulated portions of building, unless otherwise shown.

I. Trapped runs without facilities for continuous drainage are not acceptable.

J. Do not draw conductors into conduits until building is enclosed and watertight and until work which may cause cable damage has been completed.

K. Feeders shall be sized for a maximum voltage drop of 2%.

3.05 BRANCH CIRCUIT REQUIREMENTS

A. Do not use wire smaller than No. 12 AWG (unless otherwise noted) for branch circuit wiring, including motor circuits. All 20 amp, 120 volt and 277 volt branch circuit homeruns (to panelboard) serving receptacles, equipment, and lighting shall be No. 10 AWG minimum to first outlet or light fixture.

B. Size home runs for 120V branch circuits based on the overall circuit length to the furthest outlet. The following requirements shall be followed:
   1. 0 to 100 ft. circuit length: Size home run at #10 AWG minimum to first outlet.
   2. 101 to 150 ft. circuit length: Size home run at #8 AWG minimum to first outlet.
   3. 151 to 250 ft. circuit length: Size home run at #6 AWG minimum to first outlet.
   4. For other branch circuits, size conductors so that voltage drop does not exceed 3%.

C. All 120 volt and 277 volt branch circuits shall have a dedicated neutral conductor for each circuit.

D. The plans show a circuit number for each device or light. This is done for clarity. No more than three 120V or 277 circuits shall be allowed in a single home run.

E. For isolated ground receptacle circuits, provide a dedicated neutral conductor and a dedicated isolated ground conductor for each circuit.

F. Any branch circuit protected by a GFCI circuit breaker shall be provided with a dedicated neutral conductor.

3.06 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.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Clean conductor surfaces before installing lugs and connectors.

E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

F. Use compression connectors for conductor splices and taps, 6 AWG and larger. Use compression tool designed for the size and type of connector being compressed. Tape uninsulated conductors and connector with electrical tape to 150% of insulation rating of conductor.

G. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 8 AWG and smaller.

H. Stranded branch circuit conductors to be twisted counter clockwise prior to terminating under screw terminals.

I. For stranded conductors, contractor to ensure that during the wire stripping process individual strands are not damaged or removed.

3.07 MOTOR AND EQUIPMENT WIRING

A. Furnish and install motor circuits in accordance with schedules on drawings and code requirements, from source of supply to associated motor starter, and from starter to motor terminal box, including necessary and required intermediate connections.

B. Conductor and conduit size for motor branch circuits, if shown on drawings, are sized for motor requirement only. Contractor may, at his option, include associated control conductors in same conduit providing the conduit size is adjusted to meet code requirements for percentage of fill.

C. Motors shall have proper size wire as per applicable codes and nameplate ratings. Verify ratings of motors before installing wiring.

D. Obtain manufacturer's wiring diagrams of electrical equipment furnished with equipment and do not proceed to wire equipment without this information.

E. Verify all motor feeder sizes, fuse sizes, etc. recommended by equipment manufacturer before installing. Make equipment connections with flexible conduit or liquid-tight flexible metallic conduit. Properly ground non-current carrying metal parts of equipment. Where cord connections or receptacles are required, provide type "S" rubber jacketed cord, 600 volt, heavy duty service of sizes and lengths required, and receptacle as applicable.

F. Coordinate work with the other trades such that the operation of mechanical equipment will be as described in mechanical specifications.

G. Unless otherwise indicated on drawings or in specifications, motors shall be furnished, set in place, and connected to driven equipment and prepared for operation as specified in other sections. Provide final connection and proper phase relationship to achieve proper motor rotation.

3.08 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 26 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.09 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."

3.10 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.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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.

END OF SECTION

SECTION 260526

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. 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.

1.03 ACTION SUBMITTALS

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

1.04 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding 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. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems Insert locations based on NETA MTS.
      a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
      b. Include recommended testing intervals.

1.06 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 the California Electric Code (CEC), 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

2.01 CONDUCTORS

A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
   1. Solid Conductors: ASTM 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, 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. Grounding Bus: Predrilled rectangular bars of 1/4 inches annealed copper, minimum 4 by 20 inches in main electrical rooms and minimum 4 by 10 inches in all other areas, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.02 CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Panduit – Irreversible compression connectors.
2. Erico – Welded connectors.

B. Listed and labeled by a NRTL acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

C. Bolted Connectors for Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

D. Welded Connectors: Exothermic-welding kits, low-emission, electric-starting types and of types recommended by kit manufacturer for materials being joined and installation conditions.

E. Compression Connectors: Irreversible type meeting IEEE standard 837-2002 and UL listed.

F. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.03 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch diameter by10 feet.

B. Grounding Test Wells:
1. Well Pipe: 8 inch by 24 inch long pipe with belled end.
2. Well Cover: Cast iron with legend "GROUND" embossed on cover. Provide bolted, traffic rated cover.

2.04 SERVICE GROUND - CHEMICAL-ENHANCED ELECTROLYTIC GROUNDING SYSTEM

A. Description: Self-contained ground system using electrolytic action to enhance the grounding performance. Ground rod system shall be UL listed. System shall be 100% self-activating/sealed and maintenance free.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
a. System shall be as manufactured by Lyncole (800-962-2610).

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
1. Length: Minimum 10 feet long for straight (vertical) installation. Length as required for L-shaped installations.
2. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
3. Backfill Material: Shall be a natural volcanic, non-corrosive form of Lynconite II clay grout free of polymer sealants. Provide quantity of 50 lb. bags as required to meet manufacturer's installation instructions. Electrolytic grounding system shall consist of the following:
4. Protective Cover Boxes: Model XB-22F, traffic rated, protective cover boxes shall be fibrelyte composite box for traffic applications and shall include bolt down, cast iron, flush cover with 'breather' holes.

PART 3 - EXECUTION

3.01 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 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 all electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
   1. Install bus bar on insulated spacers 1 inch, minimum, from wall 18 inches above finished floor, unless otherwise indicated.

E. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors.
   3. Connections to Ground Rods at Test Wells: Welded connectors.
   4. Connections to Structural Steel: Welded connectors.
   5. Aboveground Accessible Connections: Irreversible compression or welded connectors.
   6. Connections in areas that may be a fire hazard to use welded connectors: Irreversible compression connectors.

3.02 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, nonshrink 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.

3.03 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits. Terminate each end on suitable lug, bus or bushing.

B. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide insulated grounding conductor in raceway (minimum 4 AWG) from the main service copper bus bar to each service location(s), terminal cabinet, wiring closet, and central equipment location.
   1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a copper grounding bus.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
   3. Bond all cable tray, metallic conduits, and equipment racks with minimum 6 AWG to copper bus bar.

3.04 INSTALLATION

A. Install Products in accordance with manufacturer's instructions and NECA 331.

B. 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.

C. 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.

D. Ground Rods: Drive rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

E. Chemical-Enhanced Electrolytic Grounding System Installation:
   1. Each building system service ground shall be augmented by two (2) electrolytic grounding electrodes, spaced a minimum of 20 feet apart.
   2. Install electrolytic grounding system in compliance with manufacturer’s instructions or recommendations.

F. Test Wells: Install at each ground rod. Set top of test well flush with finished grade or floor.

G. 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. Bond together metal siding not attached to grounded structure and bond to grounding electrode system.
   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.

H. 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.

I. Grounding and Bonding for dry type transformers:
   1. Step-down transformer secondaries shall be grounded to the nearest electrical room ground bus bar. Also, bond the grounded conductor of the transformer to the nearest available point of the interior metal water piping system in the area served by the transformer in accordance with NEC Article 250-104.

J. Grounding for Steel Building Structure:
   1. Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
   2. Install insulated copper grounding conductor in conduit from main electrical service copper bus bar to building structural steel.

K. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, 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 unless noted otherwise on drawings.
   2. Bury ground ring not less than 24 inches from building foundation.

L. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to CEC; use a minimum of 20 feet of bare copper conductor sized the same as building grounding electrode conductor and shall not be smaller than 4 AWG.
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Locate at or near bottom of footing with minimum 2 inches concrete encasement.
   3. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.05 TERMINATIONS AND CONNECTIONS

A. Make terminations and connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Test Wells: Use exothermic welded connections.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.06 LABELING

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems" Article for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
   1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.
   1. Manufacturer's Field Service – Electrolytic Grounding System: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
      b. Perform tests by fall-of-potential method according to IEEE 81.
   4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
   4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).
   5. Substations and Pad-Mounted Equipment: 5 ohms.
   6. Manhole Grounds: 10 ohms.

G. Excessive Ground Resistance: If resistance to ground exceeds specified values, provide additional grounding electrodes to meet values above.

END OF SECTION

SECTION 260529

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.

B. Related Sections include the following:
   1. Division 26 Section "Vibration and Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. RMC: Rigid metal conduit.

C. Corrosive Environment: Areas designated as “water treatment” or “wet”, including but not limited to areas over and within 25'-0" of open freshwater tanks, pools or basins; areas over and within 50’-0” of open saltwater tanks, pools or basins; splash zones; ozone rooms; chemical treatment rooms; salt water environments; water play areas and other water treatment zones. Refer to drawings for additional identification of areas classified as corrosive environments.

D. Wherever stainless steel is noted in corrosive areas of this specification, 316 stainless steel components shall be provided. If 316 stainless steel is not available, then provide glass-fiber-resin component.

1.04 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products. For empty conduits, include weight of 4 type XHHW wires of maximum permissible size.

1.05 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.
   2. Nonmetallic slotted support systems.

1.06 QUALITY ASSURANCE

A. Comply with the California Electric Code (CEC).

1.07 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."

C. Coordinate support of mechanical, plumbing, fire protection, electrical, telecommunications, life support systems and other trades. Piping, ductwork, conduit, etc. located in same area running parallel is to be supported on similar supports.

D. Coordinate hanger and support material with other trades such that similar materials and systems are used in common areas.

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS – NORMAL SERVICE

A. 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. GS Metals Corp.
      e. Power-Strut
      f. Thomas & Betts Corporation.
      g. Unistrut; Tyco International, Ltd.
      h. Wesanco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Channel Dimensions: Selected for applicable load criteria.
   4. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
   5. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
   6. Rated Strength: Selected to suit applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. 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.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. Power-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. Approval from structural engineer shall be obtained prior to the use of power-actuated fasteners.
      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) Hilti Inc.
         2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         3) MKT Fastening, LLC.
         4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    a. 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) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Galvanized threaded steel.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS – CORROSIVE SERVICE

A. 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.
    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. Aickinstrut
        b. Allied Tube & Conduit.
        c. Cooper B-Line, Inc.; a division of Cooper Industries.
        d. Fabco Plastics Wholesale Limited.
        e. Seasafe, Inc.
    2. Channel Dimensions: Selected for applicable load criteria.
    3. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
    4. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
    5. Rated Strength: Selected to suit applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Fiberglass or stainless steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be fiberglass or stainless steel.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M, steel plates, shapes, and bars; stainless steel.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
    1. Power-Actuated Fasteners: Threaded-stainless 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. Approval from structural engineer shall be obtained prior to the use of power-actuated fasteners.

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) Hilti Inc.
   2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
   3) MKT Fastening, LLC.
   4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless 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:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.
3. Concrete Inserts: Stainless steel or glass-fiber-resin, slotted support system units similar to MSS Type 18; complying with MFMA-4 (for stainless steel) or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: Stainless Steel.
7. Hanger Rods: Stainless Steel.
8. Raceway Box, Conduit Strap and Other Miscellaneous Screws: Stainless Steel.

2.03 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 material requirements for either normal or corrosive areas as outlined elsewhere in this specification.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter and except where support spacing requirements exceed CEC requirements.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by CEC. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted 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 for conduits 1 ¼ inch and larger, single-bolt conduit clamps for conduits 1 inch and smaller and as approved by an agency acceptable to the authority having jurisdiction.

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. 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; Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
   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].

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

E. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

F. Obtain permission from Structural Engineer before drilling or cutting structural members.

G. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

H. Install surface mounted cabinets and panelboards with minimum of four anchors.

I. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

J. Provide secondary means of support for all suspended equipment such as luminaries and speakers. If in doubt as to whether or not a secondary means of support should be provided, consult Engineer and Owner for clarification.

3.03 LUMINAIRES

A. Lay-in Ceiling Luminaires Supports: Use grid as a support element.
   1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, 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 independent support rod or wire from 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.

B. Suspended Luminaires 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 and swivel aligners.
   3. Verify stem/pendant/rod length.
   4. 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.

C. Install channel supports across main grid runners or grid supports, securely tied down or anchored for fixtures and devices mounted in suspended ceiling systems so as not to cause tile to sag and so that fixture or device cannot be lifted, rotated, or displaced.

3.04 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.

3.05 PAINTING

A. Touchup: Comply with requirements in Division 09 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 260533

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 7 Section “Through-Penetration Fire Stop Systems” for fire stopping materials and installation at penetration through walls, ceilings and other fire-rated elements.
   2. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. LFNC: Liquidtight flexible nonmetallic conduit.

F. NBR: Acrylonitrile-butadiene rubber.

G. RMC: Rigid metal conduit.

H. RNC: Rigid nonmetallic conduit.

I. Corrosive Environment: Areas designated as “water treatment” or “wet”, including but not limited to areas over and within 25'-0" of open freshwater tanks, pools or basins; areas over and within 50’-0” of open saltwater tanks, pools or basins; splash zones; ozone rooms; chemical treatment rooms; salt water environments; water play areas and other water treatment zones. Refer to drawings for additional identification of areas classified as corrosive environments.

1.04 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.05 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
   4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

1.06 QUALITY ASSURANCE

A. Listing and Labeling: Conduits, tubing, and fittings shall be listed and labeled as defined in the California Electrical Code - CEC, by a qualified testing agency, and marked for intended location and application.

1.07 PRE-INSTALLATION MEETING

A. Convene pre-installation meeting prior to installation of raceway components in casework and in walls shown to accept casework.

B. Attendees:
   1. Contractor.
   2. Electrical Subcontractor.
   3. Plumbing Subcontractor.
   4. Casework Installer.
   5. Architect.
   6. Owner (Owner's Representative).

C. Notify Architect seven days prior to meeting.

D. Prepare agenda and preside at meeting.
   1. Review locations and mounting heights of devices and outlets shown. Compare to casework shop drawings.
   2. Review routing of raceways through chases and cabinets.
   3. Verify connection components of electrified components of casework.

E. Document final locations, connection points and mounting heights where at variance with plans. Distribute documentation to affected Subcontractors and to Architect.

PART 2 - PRODUCTS

2.01 METAL CONDUITS, TUBING, AND FITTINGS

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. AFC Cable Systems, Inc.
   2. Allied Tube & Conduit; a Tyco International Ltd. Co.
   3. O-Z/Gedney; a brand of EGS Electrical Group.
   4. Robroy Industries.
   5. Southwire Company.
   6. Thomas & Betts Corporation.

B. EMT: Comply with ANSI C80.3 and UL 797.

C. FMC: Comply with UL 1; zinc-coated steel or aluminum.

D. RMC: Comply with ANSI C80.1 and UL 6.

E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
   1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
   2. Conduit Fittings for Indoor Wet Locations or Exterior: Steel insulated throat, compression, UL listed rain-tight.
   3. Fittings for EMT: Steel insulated throat, set-screw or compression type (Die-cast fittings will not be accepted).
   4. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions were installed, and including flexible external bonding jumper.

G. Joint Compound for RMC: Approved, as defined in the CEC, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.02 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

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. Anamet Electrical, Inc.
   2. Arnco Corporation.
   3. CANTEX Inc.
   4. CertainTeed Corp.
   5. Condux International, Inc.
   6. Electri-Flex Company.
   7. Kraloy.
   8. Lamson & Sessions; Carlon Electrical Products.
   9. Niedax-Kleinhuis USA, Inc.
   10. RACO; a Hubbell company.
   11. Thomas & Betts Corporation.

B. RNC: Type EPC-40-PVC**,** complying with NEMA TC 2 and UL 651 unless otherwise indicated.

C. LFNC: Comply with UL 1660.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit type and material.

E. Fittings for LFNC: Comply with UL 514B.

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

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. Cooper B-Line, Inc.
   2. Hoffman; a Pentair company.
   3. Mono-Systems, Inc.
   4. Square D; a brand of Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: Type 1.
      b. Outdoor Locations: Type 3R.
      c. Kitchen and wash-down areas: Type 4X, stainless steel.
      d. Other Wet or Damp Indoor Locations: Type 4.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: Type 12.
      f. Exterior Corrosive Locations: Type 4X, stainless steel. Refer to drawings for identification of corrosive areas.
      g. Interior Corrosive Locations: Type 4X, fiberglass. Refer to drawing for identification of corrosive areas.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type for Type 1 wireways, Flanged-and-gasketed type for Type 3R and 4X wireways.

E. Finish: Manufacturer's standard enamel finish.

2.04 BOXES, ENCLOSURES, AND CABINETS

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. Cooper Technologies Company; Cooper Crouse-Hinds.
   2. Hoffman; a Pentair company.
   3. Hubbell Incorporated; Killark Division.
   4. O-Z/Gedney; a brand of EGS Electrical Group.
   5. RACO; a Hubbell Company.
   6. Robroy Industries.
   7. Thomas & Betts Corporation.
   8. Wiremold / Legrand.

B. General Requirements: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Galvanized Steel. Comply with NEMA OS 1 and UL 514A.

D. Concrete Ceiling Boxes: 4 inch octagon, minimum depth of 3 inches.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
   1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in the CEC, by a qualified testing agency, and marked for intended location and application.

G. Cast-Metal Outlet and Device Boxes: Surface mount, NEMA FB 1, ferrous alloy, Type FD, with gasketed cover with stainless steel screws. Provide threaded hubs.

H. Device Box Dimensions: Minimum 4 inches square by 2-1/8 inches deep.

I. Sheet Metal Pull and Junction Boxes: NEMA OS 1.

2.05 SEALANTS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products for sealing exterior conduits that may be incorporated into the Work include, but are not limited to, the following:
   1. Polywater
   2. Approved Equal

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Conduit Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed: [Galvanized RMC] [RNC, Type EPC-80-PVC]
   2. Concealed, Aboveground: RMC, EMT.
   3. Underground:
      a. Outside Building Foundation: RNC, Type EPC-40-PVC, rated for direct burial.
      b. Under Slab on Grade: RNC, Type EPC-40-PVC.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.

B. Conduit Indoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed and Subject to Physical Damage: RMC below switch height and EMT above switch height, except that EMT may be used below switch height in designated equipment rooms and closets, utility chases and similar locations.
3. Includes raceways in the following locations:
   a. Loading docks.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
4. Exposed damp or wet locations: RNC, Type EPC-40-PVC
5. Concealed in Ceilings, elevated underfloor, and Interior Walls and Partitions: EMT.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
7. Concealed in Concrete Walls: RNC, Type EPC-40-PVC.
8. Connections to Lighting Fixtures in Accessible Ceilings: FMC – max 72 inches in length.
9. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: EMT.
10. Raceways for Optical Fiber or Communications Cable Risers in Vertical Shafts: EMT.
11. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.
12. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 3R in damp or wet locations.

C. Conduit Special Locations: Apply raceway products as specified below, unless otherwise indicated:
1. Interior Corrosive Areas as identified on drawings: EPC-40-PVC.
2. Exterior Corrosive Areas as identified on drawings: UV resistant EPC-40-PVC
3. Hazardous Areas: Fuel Dispensing equipment and tank areas: PVC coated Galvanized Rigid Steel.

D. Minimum Raceway Size:
1. Minimum conduit size shall be ¾ inch trade size except for switch legs and control circuits may be ½ inch.
2. Minimum FMC size shall be ½ inch except flexible connections to lighting fixtures may be 3/8 inch, not to exceed 6 feet in length

E. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

F. Boxes: Apply products as specified below, unless otherwise indicated:
1. Outdoor Locations: Type 3R, non-metallic.
2. Exposed kitchen and interior wash-down areas: Type 3R, non-metallic.
3. Other Wet or Damp Indoor Locations: Type 3R, non-metallic.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: Type 12.
5. Exterior Corrosive Locations: Type 3R, non-metallic. Refer to drawings for identification of corrosive areas.
6. Interior Corrosive Locations: Type 3R, non-metallic. Refer to drawing for identification of corrosive areas.

3.02 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with the CEC limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Conduit routing shown on drawings indicate approximate locations unless dimensioned. Route as required to complete wiring system.

D. Complete raceway installation before starting conductor installation.

E. Comply with requirements in Division 16 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

F. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

G. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

H. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

I. Support conduit within 12 inches of enclosures to which attached.

J. Raceways Embedded in Slabs:
   1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum10-foot intervals.
   2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
   3. Change from PVC to EMT or rigid steel conduit before rising above the floor.

K. Stub-ups to Above Recessed Ceilings:
   1. Use EMT or RMC for raceways.
   2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

L. Underground Conduit Bends:
   1. Conduit Bends: Where RNC is installed, all conduit bends greater than 45° in conduits 1 ½ inches trade size and larger shall be made with type EPC-80-PVC rated for direct burial, conduit elbow.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

S. Raceways for Optical Fiber and Communications Cable: Install raceways, rigid, metallic and nonmetallic, as follows:
   1. ¾ inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.

2. 1 inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Any section of conduit longer than 150 feet or containing more than two (2) 90 degree bends shall have pull boxes. These boxes are not shown on drawings.
4. Communications conduits shall be separated from power conduits. Coordinate with Communications, Specialty Contractors, and Building Industry Consulting Service International (BICSI) recommendations.

T. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Areas where conduits are in water such as fountains and pools.
3. Where otherwise required by the CEC.

U. Seal end of conduit when raceway terminates outdoors above grade and is exposed to infiltration by water.

V. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RNC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
   c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
   d. Attics: 135 deg F temperature change.
3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
3. Use LFNC in corrosive areas.

X. Conduit Routing:
1. Arrange conduit to maintain headroom and present neat appearance.
2. Route exposed conduit parallel and perpendicular to walls.
3. Route conduits in accessible ceilings to clear access openings.
4. Maintain adequate clearance between conduit and piping.
5. Maintain 12 inches clearance between conduit and surfaces with temperatures exceeding 104 deg F.

Y. Cut conduit square using saw or pipe cutter; de-burr cut ends.

Z. Use conduit bodies to make sharp changes in direction, as around beams.

AA. Provide suitable fittings to accommodate expansion and deflection where conduit crosses control and seismic expansion joints.

BB. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

CC. Termination of Conduit Stubs:
1. Underground and Flush with Finish Floor: Use coupling and threaded plug.
2. Above Floor: Use conduit bushing.
3. Signal Systems: Use conduit bushing.

DD. Make conduit penetrations of exterior concrete or masonry walls below grade, and of floor slabs on fill below grade, watertight.

EE. Set metal floor boxes level and flush with finished floor surface.

3.03 OUTLET BOX INSTALLATION

A. Location of outlets and equipment as shown on drawings is approximate, and exact location shall be verified and shall be determined by:
1. Construction or code requirements.
2. Conflict with equipment of other trades.
3. Equipment manufacturer's drawings.
4. As dimensioned on interior or architectural elevations/plans as long as in compliance with all applicable codes.

B. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

C. Use plaster rings for all concealed work except for masonry boxes; depth of rings as required to reach finished surface.

D. Use masonry boxes with square corners in tile, marble, brick or concrete block.

E. Do not fasten boxes to ceiling support wires and support boxes independently of conduit.

F. Orient boxes to accommodate wiring devices oriented as specified in Division 16 Section “Wiring Devices”.

G. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.

H. Conflict with millwork, tack boards, etc. Coordinate mounting heights and location of outlets mounted above counters, benches and backsplashes. Contractor shall review architectural elevations and millwork drawings before roughing-in boxes and conduit. Any conflicts shall be noted and addressed by an RFI requesting direction as to resolution. Adjusting box locations due to such conflicts shall be at no additional compensation.

I. Minor modification in the location of outlets and equipment is considered incidental up to a distance of 10 feet with no additional compensation, providing necessary instructions are given prior to roughing in of outlet.

J. Electrical outlet boxes may be installed in vertical fire resistive assemblies classified as fire/smoke and smoke partitions without affecting the fire classification, provided such openings do not exceed 16 square inches and they are located per applicable U.L. assembly. All clearances between such outlet boxes and the gypsum board must be completely filled with joint compound or other approved materials. The wall must be built around outlets of a larger size so as to not interfere with the integrity of the wall rating. The aggregate surface area of the boxes shall not exceed 100 square inches per 100 square feet. Boxes located on opposite sides of walls or partitions shall be separated by a horizontal distance of 24 inches or by providing listed putty pads around both boxes. The metallic outlet or switch boxes shall be securely fastened to the studs and the opening in the wallboard facing shall be cut so that the clearance between the box and the wallboard does not exceed 1/8 inch.

K. Do not install boxes back to back or through wall. Offset outlet boxes on opposite sides of wall a minimum of 12 inches or on opposite sides of stud in partition walls. Where back to back boxes cannot be avoided, provide gypsum board between boxes.

L. Where more than two switches or devices are located at one point, use ganged boxes and covers, unless devices do not allow for ganging or manufacturer recommends otherwise. Provide permanently installed barriers between adjacent switches as required to meet regulatory requirements.

M. Align adjacent wall mounted outlet boxes for switches, thermostats and similar devices.

3.04 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 16 Section "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.05 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.06 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 260536

CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes aluminum cable trays and accessories.

1.03 ACTION SUBMITTALS

A. Product Data: Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.
   1. Show fabrication and installation details of cable tray, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, fire penetration assemblies, straight lengths, and fittings.

1.04 INFORMATIONAL SUBMITTALS

A. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
   1. Design Calculations: Calculate requirements for selecting seismic restraints.
   2. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

B. Coordination Drawings: Floor plans and sections, drawn to scale. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements. Show the following:
   1. Vertical and horizontal offsets and transitions.
   2. Clearances for access above and to each side of cable trays.
   3. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

C. Field quality-control reports.

D. Operation and Maintenance Data: Include approved shop drawing and product data.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain cable tray components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in California Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 COORDINATION

A. Coordinate location of cable tray with mechanical ducts and piping of other trades as required.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store indoors to prevent water or other foreign materials from staining or adhering to cable tray. Unpack and dry wet materials before storage.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Chalfant.
   2. Cooper B-Line, Inc.
   3. Cope, T. J., Inc.; a subsidiary of Allied Tube & Conduit.
   4. Mono-Systems, Inc.
   5. PW Industries.
   6. Wiremold.

2.02 MATERIALS AND FINISHES

A. Cable Trays, Fittings, and Accessories: Aluminum, ladder type**,** complying with NEMA VE 1, Aluminum Association's Alloy 6063-T6 for rails, rungs, and cable trays, and Alloy 5052-H32 or Alloy 6061-T6 for fabricated parts; with chromium-zinc, ASTM F 1136, splice-plate fasteners, bolts, and screws

B. Sizes and Configurations:
   1. Width: As shown on drawings.
   2. Rung spacing: 6 inches.
   3. Loading depth: 3 inches.
   4. Nema Class 12B.
   5. Fit ends of all rungs with plastic cap to prevent damage to the cable and injury to the installer.

2.03 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.04 WARNING SIGNS

A. Lettering: 1-1/2-inch- high, black letters on yellow background with legend “WARNING! NOT TO BE USED AS WALKWAY, LADDER, OR SUPPORT FOR LADDERS OR PERSONNEL.”

B. Materials and fastening are specified in Division 26 Section “Identification for Electrical Systems.”

2.05 SOURCE QUALITY CONTROL

A. Perform design and production tests according to NEMA VE 1.

PART 3 - EXECUTION

3.01 CABLE TRAY INSTALLATION

A. Comply with recommendations in NEMA VE 2. Install as a complete system, including all necessary fasteners, hold-down clips, splice-plate support systems, barrier strips, hinged horizontal and vertical splice plates, elbows, reducers, tees, and crosses.

B. Remove burrs and sharp edges from cable trays.

C. Fasten cable tray supports to building structure and install seismic restraints.
   1. Design each fastener and support to carry load indicated by seismic requirements and to comply with seismic-restraint details according to Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
   2. Place supports so that spans do not exceed maximum for NEMA class.

3. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
4. Support assembly to prevent twisting from eccentric loading.
5. Manufacture center-hung support, designed for 60 percent versus 40 percent eccentric loading condition, with a safety factor of 3**.**
6. Locate and install supports according to NEMA VE 1.
7. Do not attach any parts of the cable tray system to air conditioning duct system.
8. Install stiffener bars along the length of the tray run when length of threaded hanger rod exceeds 3 feet.

D. Make connections to equipment with flanged fittings fastened to cable tray and to equipment. Support cable tray independent of fittings. Do not carry weight of cable tray on equipment enclosure.

E. Install expansion connectors where cable tray crosses building expansion joint and in cable tray runs that exceed dimensions recommended in NEMA VE 1. Space connectors and set gaps according to applicable standard.

F. Make changes in direction and elevation using standard fittings.

G. Run cable trays parallel to or right angles with the building coordinates without unnecessary offsets or bends.

H. Make cable tray connections using standard fittings.

I. Seal penetrations through fire and smoke barriers according to Division 07 Section "Penetration Firestopping."

J. Sleeves for Future Cables: Install capped sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

K. Workspace: Install cable trays with enough space to permit access for installing cables. Maintain a minimum clearance of 6 inches between top of tray and material of other trades.

L. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

M. After installation of cable trays is completed, install warning signs in visible locations on or near cable trays.

N. Attach conduits stubbed to cable tray shall be attached to tray using conduit bushing dropout fittings.

O. Install cable tray to completely penetrate walls into IDF’s (six-inches into room) where shown entering IDF’s from corridors.

3.02 CABLE INSTALLATION

A. Install cables only when cable tray installation has been completed and inspected.

B. On vertical runs, fasten cables to tray every 18 inches. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

3.03 CONNECTIONS

A. Ground cable trays according to manufacturer's written instructions and Division 26. Use tray as an equipment ground conductor for itself only, not for connected equipment.

3.04 FIELD QUALITY CONTROL

A. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements. Perform the following field quality-control survey:

1. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable tray, vibration, and thermal expansion and contraction conditions, which may cause or have caused damage.
2. Verify that the number, size, and voltage of cables in cable tray do not exceed that permitted by CEC. Verify that communication or data-processing circuits are separated from power circuits by barriers.
3. Verify that there is no intrusion of such items as pipe, hangers, or other equipment that could damage cables.
4. Remove deposits of dust, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
6. Check for missing or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
7. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable tray.

B. Report results in writing.

3.05 PROTECTION

A. Protect installed cable trays.
1. Install temporary protection for cables in open trays to protect exposed cables from falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials until the risk of damage is over.
2. Keep cable tray clean in a manner to prevent entry of moisture and foreign materials until conductors are installed. Sweep out and clean all trays before installing conductors.

END OF SECTION

SECTION 260543

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
   2. Handholes and boxes.
   3. Manholes.

1.03 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Duct-bank materials, including separators and miscellaneous components.
   2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Accessories for manholes, handholes, boxes.
   4. Warning tape.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Reinforcement details.
   3. Frame and cover design and manhole frame support rings.
   4. Ladder details.
   5. Grounding details.
   6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
   7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Cover design.
   3. Grounding details.
   4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.05 INFORMATIONAL SUBMITTALS

A. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

B. Source quality-control test reports.

C. Field quality-control test reports.

1.06 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with the California Electrical Code (CEC).

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.08 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 Construction Manager and/or Owner no fewer than twenty-four hours in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's and/or Owner's written permission.

1.09 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 - PRODUCTS

2.01 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.02 NONMETALLIC CONDUIT ACCESSORIES

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. ARNCO Corp.
   2. Beck Manufacturing.
   3. Cantex, Inc.

B. Duct Accessories:
   1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
   2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.03 PRECAST CONCRETE HANDHOLES AND BOXES

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. Carder Concrete Products.
2. Christy Concrete Products.
3. Oldcastle Precast Group.
4. Utility Concrete Products, LLC.
5. Utility Vault Co.
6. San Diego Precast.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
   1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
   2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
   3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
      a. Cover Hinges: Concealed, with hold-open ratchet assembly.
      b. Cover Handle: Recessed.
   4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
      a. Cover Hinges: Concealed, with hold-open ratchet assembly.
      b. Cover Handle: Recessed.
   5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   6. Cover Legend: Molded lettering, As indicated for each service.
   7. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
   8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
      a. Extension shall provide increased depth of 12 inches.
      b. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
   9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
      a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
      b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
      c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
   10. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.
   1. Color: Gray.
   2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, As indicated for each service.

6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
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. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. NewBasis.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.
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. Carson Industries LLC.
b. Christy Concrete Products.
c. Nordic Fiberglass, Inc.
d. Quazite, Inc.

2.05 UTILITY STRUCTURE ACCESSORIES

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. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. Elmhurst-Chicago Stone Co.
6. McKinley Iron Works, Inc.
7. Neenah Foundry Company.
8. NewBasis.
9. Oldcastle Precast Group.
10. Osburn Associates, Inc.
11. Pennsylvania Insert Corporation.
12. Underground Devices, Inc.
13. Utility Concrete Products, LLC.
14. Utility Vault Co.
15. Wausau Tile, Inc.

B. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- diameter eye, and 1-by-4-inch bolt.
1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

C. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch- diameter eye, rated 2500-lbf minimum tension.

D. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

E. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

F. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

G. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
   1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.
   2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

H. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

I. Fixed Manhole Ladders: Arranged for attachment to roof or wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

J. Cover Hooks: Light duty, designed for lifts less than 60 lbf. Two required.

2.06 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete encased ductbank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

F. Underground Ducts Crossing Driveways and Roadways: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.02 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
   1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
   2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete**,** structural load rating.
   3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
   4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Manholes: Precast or cast-in-place concrete.
   1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
   2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.03 EARTHWORK

A. Excavation and Backfill: Comply with Division 2 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.04 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
   1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
   2. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

F. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

G. Underground Conduit Bends:

Conduit Bends: Where RNC is installed, all conduit bends greater than 45° in conduits 1 ½ inches trade size and larger shall be made with type EPC-80-PVC rated for direct burial, conduit elbow**.**

H. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations or use other specific measures to prevent expansion-contraction damage.
      b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
   3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
   4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
   5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
   6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 12 inches between power and signal ducts.
   7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
   8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
   9. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

I. Direct-Buried Duct Banks - Direct Buried and Concrete Capped:
   1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
   2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
   3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 3 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
   4. Install backfill as specified in Division 3 Section "Earth Moving."

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches between ducts for like services and 12 inches between power and signal ducts.
7. Depth:
   a. Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated for main service entrance.
   b. Install top of duct bank at least 30 inches below finished grade, unless otherwise indicated for branch circuits.
   c. Install top of duct bank at least 24 inches below finished grade, unless otherwise indicated for communications systems.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Provide 4 inches thick concrete cap the entire width and length of the underground duct. Concrete shall have red dye inserted into mix,

3.05 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:
   1. Finish interior surfaces with a smooth-troweled finish.
   2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
   3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 03 Section "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:
   1. Comply with ASTM C 891, unless otherwise indicated.
   2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
   3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:
   1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
   2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
   3. Install handholes with bottom below the frost line, below grade.
   4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
   5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
   1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
   2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

E. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Division 07 Section "[**Elastomeric Sheet Waterproofing**] [**Thermoplastic Sheet Waterproofing**]." After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

F. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 07 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

G. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, as required for installation and support of cables and conductors and as indicated.

H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

K. Drainage Provisions: Provide 12 inch thick gravel bed under manhole, handhole, and box extending 12 inches beyond footprint of box.

3.06 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. Drainage Provisions: Provide 12 inch thick gravel bed under handhole and box extending 12 inches beyond footprint of box

3.07 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.08 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
   3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.09 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 260544

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal systems.
   3. Sleeve-seal fittings.
   4. Grout.
   5. Silicone sealants.

B. Related Requirements:
   1. Division 07 Section "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.01 SLEEVES

A. Wall Sleeves:
   1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
   2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:
   1. Material: Galvanized sheet steel.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.02 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Advance Products & Systems, Inc.
      b. CALPICO, Inc.
      c. Metraflex Company (The).
      d. Pipeline Seal and Insulator, Inc.

e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Carbon steel.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. 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. Presealed Systems.

2.04 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
   a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
   b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.02 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.03 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 260549

SEISMIC RESTRAINT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Related Requirements:
   1. Division 26 Section “Hangers and Supports for Electrical Systems” for commonly used electrical supports and installation requirements.

1.03 DEFINITIONS

A. ASCE: American Society of Civil Engineers.

B. IBC: International Building Code.

C. CBC: California Building Code.

D. Life Safety / Emergency Systems:
   1. All systems involved with fire protection, including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust.
   2. All systems involved with production and distribution of and utilization equipment connected to emergency power supply, including all generators, transfer switches, transformers and all circuits to fire protection, smoke evacuation and/or emergency lighting systems.
   3. All medical and life support systems.
   4. Fresh air and relief systems on emergency smoke control sequence, including air handlers, conduit, duct, dampers, fans, etc.

1.04 PERFORMANCE REQUIREMENTS

A. Equipment and Distribution Components: Design supports, attachments, and restraints according to IBC, CBC and ASCE 7-05 as Delegated-Design.

B. Use seismic design values shown on structural drawings.

C. Treat components that are part of life safety /emergency systems as having Component Importance Factor = 1.5. Treat other components as having Component Importance Factor = 1.5 if so scheduled on the drawings.

1.05 INFORMATIONAL SUBMITTALS

A. Delegated-Design Submittal: For seismic restraint details governed by performance requirements, include analysis data signed and sealed by a professional engineer responsible for their preparation who is qualified for such work in the place of the project.
   1. Design Calculations: Calculate loading due to equipment weight, operation, and seismic forces required to select seismic restraints.
      a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors.
   2. Include materials and dimensions and identify hardware, including attachment and anchorage devices, for equipment and for manufactured and field fabricated supports.
   3. Seismic Restraint Details:
      a. Design Analysis: Support selection and arrangement of seismic restraints.
      b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Identify components, identify components, list their

strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices, where applicable.

c. Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

B. Coordination Drawings: Show proposed locations of supports and restraints for distribution system components.
   1. Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
   2. Reference proposed locations of supports and restraints to Delegated-Design Submittal details.

1.06 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel".

C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage pre approved by ICC-ES, or preapproved by another agency acceptable to authorities having jurisdiction showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a State of California licensed structural engineer.

PART 2 - PRODUCTS

2.01 SEISMIC-RESTRAINT DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide products of Mason Industries or a comparable product by one of the following:
   1. Cooper B-Line, Inc.; a division of Cooper Industries.
   2. Hilti Inc.
   3. Loos & Co.; Seismic Earthquake Division.
   4. ISAT.
   5. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components:
   1. Components used in Delegated-Design details: Rated strengths, features, and application requirements shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

2.02 FACTORY FINISHES

A. Finish: Manufacturer's standard paint or galvanized.
   1. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive seismic restraint devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing in of reinforcement and cast-in-place anchors to verify actual location before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATION

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze members with clamps approved for application by an agency acceptable to authorities having jurisdiction.

3.03 SEISMIC RESTRAINT DEVICE INSTALLATION

A. Install seismic restraint devices for distribution components according to Delegated-Design details.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections: Test and inspect to meet regulatory requirements.

END OF SECTION

SECTION 260553

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   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.

1.03 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with California Electrical Code (CEC).

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.04 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 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.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.02 FLOOR MARKING TAPE

A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.03 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 6 inches wide by 4 mils thick.
   2. Embedded continuous metallic strip or core.
   3. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   4. Printing on tape shall be permanent and shall not be damaged by burial operations.
   5. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.04 WARNING LABELS AND SIGNS

A. Comply with CEC and 29 CFR 1910.145.

B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 1/2 inch.

C. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.05 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.06 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 1/2 inch.

2.07 CABLE TIES

A. 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 except where used for color-coding.

B. 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 except where used for color-coding.

2.08 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, except contact type permanent commercial grade adhesive providing a permanent bond shall be used where screws cannot or should not penetrate substrate.

C. Two-sided tape and dynamo type adhesives are not acceptable.

PART 3 - EXECUTION

3.01 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. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Indoors and Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

G. 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 or concrete envelope exceeds 16 inches overall.

H. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.02 IDENTIFICATION SCHEDULE

A. Colors for Metal Clad Cable and Accessible Raceways Carrying Circuits at 600 V or Less:
   1. Paint all junction boxes, junction box covers, and conduit fittings using color code legend.
   2. Legend:
      a. Emergency Systems – Yellow

B. Colors for Raceways for Low Voltage Systems:
   1. Paint all junction boxes, junction box covers, and conduit fittings using color code legend.
   2. Legend:
      a. Fire Alarm System – Red
      b. CCTV System – Brown
      c. CATV System – Black
      d. Access Control System - Purple
      e. Telecommunications System (Voice/Data) - White
   3. If existing color coding is different than indicated above, match existing color coding.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in panelboards, switchboards, switchgear, vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors and neutral and ground conductors.
    a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    b. Colors for 208/120-V Circuits:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.
        4) Neutral: White.
        5) Ground: Green.
        6) Isolated Ground: Green/Yellow Tracer.
    c. Colors for 480/277-V Circuits:
        1) Phase A: Brown.
        2) Phase B: Orange.
        3) Phase C: Yellow.
        4) Neutral: Gray.
        5) Ground: Green.
        6) Isolated Ground: Green/Yellow Tracer.
    d. If existing color coding is different than indicated above, match existing color coding.
2. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

E. Install instructional sign in each main electrical room including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

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. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. At each junction box, the covers on junction boxes and pull boxes in areas that are not to be painted shall be marked with “Indelible Markers” to indicate the circuit number(s) of conductors in the box. In areas where exposed conduit and junction boxes are to be painted, indicate circuit number(s) of conductors in the box on the inside cover of the box.

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.

K. 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.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with design documents. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 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:
      a. Panelboards.
      b. Enclosures and electrical cabinets.
      c. Access doors and panels for concealed electrical items.
      d. Disconnects
      e. Switchgear.
      f. Switchboards.
      g. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
      h. Substations.
      i. Emergency system boxes and enclosures.
      j. Motor-control centers.
      k. Enclosed switches.
      l. Enclosed circuit breakers.
      m. Enclosed controllers.
      n. Variable-speed controllers.
      o. Power transfer equipment.
      p. Contactors.
      q. UPS equipment.
      r. Lighting Control Equipment
      s. Power Inverters

M. Engraved laminate signs shall have white lettering in a black field.

N. Where the electrical system is comprised of normal power and emergency power, the equipment connected to the normal power system shall have engraved laminate signs with white lettering in a black field. Equipment connected to the emergency power system shall have engraved laminate signs with white lettering in a red field.

O. Panelboard identification shall indicate panelboard designation, voltage and where fed from, i.e., "PANEL 1LA - 120/208V, 3 PHASE, 4W".
FED FROM 1MDPHA"

P. Panelboards located in storage rooms shall have floor space per NEC-110 permanently marked and shall be identified as "Electrical Access - Not For Storage."

3.03 COVER PLATES

A. All wiring device cover plates shall have panel designation and circuit number (i.e."1HLA-7") serving device clearly marked on the front of each faceplate with indelible marker for all back of

house items, and clearly marked on the back of each faceplate with indelible marker for all front of house items.

3.04 PANELBOARD CIRCUIT DIRECTORIES

A. Install in each panelboard a typewritten directory accurately indicating rooms and equipment being served. Verify actual room names and numbers to be used. Also, provide a copy of typewritten panelboard directories in Owner's close-out manuals.

B. Where new circuits are added to existing panelboards or existing circuits deleted, provide new typewritten panelboard circuit directory with added circuits identified and deleted circuits indicated as 'spare'. Circuit identification shall indicate room and equipment being served.

3.05 ENCLOSED MOTOR CONTROLLERS

A. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor and voltage/phase rating.

END OF SECTION

SECTION 260573

SYSTEM STUDIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes computer-based, electrical system studies, including:
   1. Fault current study.
   2. Protective device coordination study.
   3. Arc flash hazard study.

B. Protective devices shall be set based on results of the protective device coordination study.

C. Provide a selectively and fully coordinated system in accordance with California Electric Code (CEC), for the CEC Article 700 Emergency Systems and Article 701 Legally Required Standby Systems, state and local requirements. Provide coordination settings to achieve best possible coordination for normal (non CEC article 700, 701) branches of power unless noted on drawings.

D. Overcurrent devices shall be selected to achieve selective coordination down to a 0.1 second level. There shall be no overlap between devices to this level.

1.03 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Other Action Submittals: Submittals shall be in digital form, except as noted.
   1. Study input data, including completed computer program input data sheets, and single line diagrams of existing and new system equipment.
   2. Study and Equipment Evaluation Reports.
   3. SKM PowerTools input and output files used in developing system studies.
   4. Provide a tabulation of settings for all overcurrent device adjustable trips, time delays, relays and ground fault coordination for all overcurrent devices in the system
   5. Sample Arc flash hazard warning label.

1.04 INFORMATIONAL SUBMITTALS

A. Qualification Data: For systems study specialist.

B. Product Certificates: For system studies computer software programs, certifying compliance with IEEE 399.

1.05 CLOSEOUT SUBMITTALS

A. Provide final approved system studies in electronic PDF form on DVD.

B. Provide SKM electronic data file of approved system studies.

C. Completed Arc flash hazard warning labels (1 set).

1.06 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. System 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 studies. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Comply with IEEE 1584 for arc flash hazard study.

F. Comply with NFPA-70E for arc flash hazard personal protective equipment (PPE) and label requirements.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Subject to compliance with requirements, provide products by SKM Systems Analysis, Inc.

2.02 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.
   1. Required Features:
      a. Arcing faults.
      b. Simultaneous faults.
      c. Explicit negative sequence.
      d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance.
   1. Fault current study and coordination study shall be completed and approved prior to submittal of electrical equipment including, but not limited to, switchgear, switchboards, distribution panelboards, panelboards, motor control centers, circuit breakers, disconnect switches, transfer switches, variable frequency drives and other equipment required to have withstand or interrupting capability. Ordering of equipment prior to approval of fault study shall be at Contractor’s risk. Any modifications to equipment ratings required as a result of the approved fault current study shall be provided by Contractor at no cost to the owner.
   2. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study. Ordering of equipment prior to approval of the coordination study shall be at Contractor’s risk. Any modifications to equipment required as a result of the approval coordination study shall be provided by Contractor at no cost to the owner.
   3. Proceed with arc flash hazard study only after coordination study protective device settings have been approved.

3.02 POWER SYSTEM DATA

A. Study to include both new equipment and existing equipment being connected to the new power distribution system.

B. Gather and tabulate the following input data to support system studies:
   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.
      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, variable frequency drive, disconnect switch ampacity, and interrupting rating in amperes rms symmetrical.
      k. Transfer switch ampacity and withstand rating.

3.03 FAULT-CURRENT STUDY

A. Study to include both new equipment and existing equipment being connected to the new power distribution system.

B. 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 electrical system components, including but not limited to the following:
   1. Switchgear and switchboard bus.
   2. Medium-voltage equipment.
   3. Distribution panelboard.

4. Branch circuit panelboard.
5. Variable frequency drive.
6. Disconnect switch.
7. Transfer switch.

C. 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.

D. Calculate momentary and interrupting duties on the basis of maximum available fault current.

E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 242.
1. Transformers, as applicable:
   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. Medium-Voltage Circuit Breakers: IEEE C37.010.
3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
4. Low-Voltage Fuses: IEEE C37.46.

F. Study Report:
1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

G. Equipment Evaluation Report:
1. For 600-V overcurrent protective devices and equipment, ensure that interrupting ratings and withstand 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.

3.04 COORDINATION STUDY

A. Study to include both new equipment and existing equipment being connected to the new power distribution system.

B. 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.

C. Comply with IEEE 242 recommendations for fault currents and time intervals.

D. 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.

E. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

F. 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.

G. Selective Coordination Settings: Select overcurrent protective device setting to achieve selective coordination for those systems as required by the CEC, state and local requirements.

H. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
   1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      a. Device tag.
      b. 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. Generator damage curve, line-to-ground decrement curve and three phase decrement curve.
      h. Maximum fault-current cutoff point.

I. Completed data sheets for setting of overcurrent protective devices.

3.05 ARC FLASH HAZARD STUDY

A. Study to include both new equipment and existing equipment being connected to the new power distribution system.

B. Perform an arc flash hazard study using approved computer software program.

C. The arc flash hazard study shall include all significant locations in the electrical distribution system when work could be performed on energized parts. Locations shall include, but not be limited to, the following:
   1. Switchboard.
   2. Panelboard.
   3. Enclosed Circuit breaker.
   4. Disconnect Switch.
   5. Variable frequency drive.
   6. Transfer Switch.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

E. The fault current calculations and the clearing times of the phase overcurrent devices shall be retrieved from the fault current and coordination study model. Ground overcurrent relays shall not

be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The fault current calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum contributions of fault current magnitude for all normal and emergency operating conditions. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
   1. Fault contribution from induction motors shall not be considered beyond 3-5 cycles.
   2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a main overcurrent protective device, calculations for incident energy and flash protection boundary shall include both the line and bus side of the main device.

I. When performing incident energy calculations on the line side of a main device (as required above), the line side and bus side contributions must be included in the fault calculation.

J. Arc flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584.

K. Calculate the following for each equipment location for line side and bus side, as appropriate:
   1. Flash hazard protection boundary.
   2. Limited approach boundary.
   3. Restricted boundary.
   4. Prohibited boundary.
   5. Incident energy level.
   6. Required personal protective equipment class.
   7. Type of fire rated clothing.

L. Study Report
   1. Study report shall include pertinent data, procedures, assumptions, results, and recommendation for arc flash hazard reduction.
   2. Provide an arc flash hazard evaluation summary listing the following:
      a. Bus name.
      b. Upstream protective device name, type and settings.
      c. Bus line to line voltage.
      d. Bus bolted fault.
      e. Protective device bolted fault current.
      f. Arcing fault current.
      g. Protective device trip/delay time.
      h. Breaker opening time.
      i. Solidly grounded column.
      j. Equipment type.
      k. Gap.
      l. Arc flash boundary.
      m. Working distance.
      n. Incident energy.
      o. Required protective fire rated clothing type and class.

M. Arc Flash Hazard Label
   1. Provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each equipment location analyzed.
   2. All labels shall be based on recommended overcurrent device settings and shall be provided after the results of the study have been approved.
   3. Each label shall include the following information, at a minimum:
      a. Equipment designation.
      b. Nominal voltage.
      c. Flash hazard protection boundary.
      d. Hazard risk category.
      e. Incident energy.
      f. Limited approach boundary.
      g. Restricted boundary.
      h. Prohibited boundary.
      i. Date of issue.

N. Contractor shall field install arc flash hazard labels.

3.06 OVERCURRENT PROTECTIVE DEVICE SETTINGS

A. Manufacturer's Field Service: Engage a factory-authorized service representative of electrical distribution equipment being set and adjusted to assist in setting of over-current protective devices within equipment.

B. Testing: Engage qualified independent testing agency to perform the following device setting and to prepare test reports.
   1. Verify that overcurrent protective devices meet parameters used in studies.
   2. Adjust devices to values listed in study results.

END OF SECTION

SECTION 260923

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following lighting control devices:
   1. Outdoor and indoor photoelectric switches.
   2. Emergency shunt relays.

B. Related Sections include the following:
   1. Division 26 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.03 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.04 SUBMITTALS FOR REVIEW

A. Shop Drawings: Interconnection diagrams showing field-installed wiring.

1.05 SUBMITTALS FOR INFORMATION

A. Field quality-control test reports.

B. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Approved by California Energy Commission.

1.07 WARRANTY

A. In addition to the requirements of the general conditions, warrant performance of occupancy sensors.

B. Include labor and material costs of remediating performance failure.

PART 2 - PRODUCTS

2.01 EMERGENCY SHUNT RELAY

A. Basis-of-Design Product: Subject to compliance with requirements, provide Watt Stopper ELCU Series as indicated on drawings or comparable product by one of the following:
   1. Functional Devices Inc.

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
   1. Coil Rating: 120/277V.

2.02 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 26120 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26120 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26120 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.01 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26120 "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 nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.02 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26020 "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.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

   1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Lighting control devices will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.04 DEMONSTRATION

A. 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

SECTION 261200

MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:
   1. Dry-type distribution and power transformers.
   2. Pad-mounted, liquid-filled transformers.

1.03 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.04 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.

1.05 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control test reports.

C. Field quality-control test reports.

D. Follow-up service reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the California Electrical Code (CEC), by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C2.

D. Comply with ANSI C57.12.10, ANSI C57.12.28, ANSI C57.12.29, IEEE C57.12.70, and IEEE C57.12.80.

E. Comply with the CEC.

F. Transformers shall be of the manufacturer's latest design, meet January 2010 DOE efficiency standards and sized and/or modified to meet the ratings and performance requirements specified herein.

1.08 PROJECT CONDITIONS

A. Service Conditions: IEEE C37.121, usual service conditions except for the following:
   1. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
   2. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
   3. Exposure to excessively high or low temperatures.
   4. Unusual transportation or storage conditions.
   5. Unusual grounding-resistance conditions.
   6. Unusual space limitations.

1.09 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 louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Asea Brown Boveri (ABB) transformers or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
   1. Cooper Industries; Cooper Power Systems Division.
   2. Cutler-Hammer.
   3. GE Electrical Distribution & Control.
   4. Siemens Energy & Automation, Inc.
   5. Square D; Schneider Electric.

2.02 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

A. Description: ANSI C57.12.13, ANSI C57.12.26, IEEE C57.12.00, pad-mounted, 2-winding transformers. Stainless-steel tank base.

B. Edible-Seed-Oil-Based Dielectric: Listed and labeled by an NRTL as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic, having passed the Organisation for Economic Co-operation and Development G.L.203 with zero mortality, and shall be certified by the U.S. Environmental Protection Agency as biodegradable, meeting Environmental Technology Verification requirements.

C. The transformer(s) shall be rated as shown on drawings. Primary and secondary voltages shall be as shown on drawings.

D. Basic Impulse Level**:** 95 kV.

E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.

F. The average winding temperature rise above ambient temperature, when tested at the transformer rating shall not exceed 65°C.

G. The percent impedance voltage, as measured on the rated voltage connection, shall be per Table 2. For target impedances, the tolerance on the impedance shall be +/- 7.5% of nominal value for impedance values greater than 2.5%. The tolerance on the impedance shall be +/- 10.0% for impedance values less than or equal to 2.5%.

Table 2 - Percent Impedance Voltage

KVA Rating (Low voltage < 700 V)	Impedance
75	1.10 - 5.75
112.5-300	1.40 - 5.75
500	1.70 - 5.75
750-3750	5.75 nominal

KVA Rating	Low voltage > 700 V (all nominal values)		
	≤150 kV BIL	200 kV BIL	250 kV BIL
1000 - 5000	5.75	7.00	7.50
7500 - 10000	6.50	7.00	7.50

H. High Voltage Bushings and Terminals:
1. Bushing Style:
   a. FOR 15/25 KV DEADFRONT: The high voltage bushings shall be 15/25 kV 200A bushing wells with bushing well inserts installed. The bushings shall be externally removable and be supplied with a removable stud. (Examples: Cooper Power Systems catalog sections 800-32, 500-12, and 500-26)
2. Bushing Configuration:
   a. 15/25 KV LOOP FEED DEADFRONT: The transformer shall be provided with six (6) high voltage bushings in accordance ANSI C57.12.34 for loop feed configurations. The bushing heights shall be in accordance with ANSI C57.12.34.

I. Secondary Voltage Bushings and Terminals:
1. Bushing Style:
   a. For voltages less than 700 Volts: The transformer shall be provided with tin-plated spade-type bushings for. The spacing of the connection holes shall be 1.75” on center, per ANSI C57.12.34 figure 13. The quantity of connection holes shall be 12 holes.
   b. Bushing supports shall be provided for units requiring 10 or more connection holes. Bushing supports shall be attached to the cabinet sidewalls; tank-mounted support mountings are not acceptable.
2. Bushing Configuration:
   a. The transformer shall be provided with bushings in a staggered arrangement in accordance with ANSI C57.12.34.

J. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.
1. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.
2. Internal liquid-immersed cartridge fuses.

3. Bay-O-Net liquid-immersed fuses that are externally replaceable without opening transformer tank.
4. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.

K. Transformer Protection and Switching:
1. Overcurrent Protection:
a. Bayonet with current limiting fuses: The high-voltage overcurrent protection scheme provided with the transformer shall be an externally removable loadbreak expulsion Bay-O-Net fuse assembly with a flapper valve to minimize oil spillage. The bayonet fuses shall be in series with ELSP under-oil partial-range current-limiting back-up fuses with an interrupting rating of 50,000 A.
2. Overvoltage Protection:
a. The overvoltage protection scheme provided with the transformer shall protect the high-voltage winding.
b. With DEADFRONT bushings: Externally mounted, Distribution Class M.O.V.E. Deadfront elbow arresters shall be supplied.
3. Switching: The primary switching scheme provided with the transformer shall be three on/off loadbreak switch.

L. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for radial-feed and six arresters for loop-feed circuits.

M. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
1. Bushing-Well Inserts: One for each high-voltage bushing well.
2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
3. Parking Stands: One for each high-voltage bushing well.
4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

N. General Design:
1. Core and coil
a. The core and coil shall be vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system. While under vacuum, the windings will be energized to heat the coils and drive out moisture, and the transformer will be filled with preheated filtered degassed insulating fluid. The core shall be manufactured from burr-free, grain-oriented silicon steel and shall be precisely stacked to eliminate gaps in the corner joints. The coil shall be insulated with B-stage, epoxy coated, diamond pattern, insulating paper, which shall be thermally cured under pressure to ensure proper bonding of conductor and paper.
2. Dielectric fluid
a. The dielectric coolant shall be listed less-flammable fluid meeting the requirements of National Electrical Code® Section 450-23 and the requirements of the National Electrical Safety Code (IEEE C2-1997), Section 15. The dielectric coolant shall be readily and completely biodegradable per EPA OPPTS 835.3100. The base fluid shall be 100% derived from edible seed oils with performance enhancing additives. The fluid shall result in zero mortality when tested on trout fry per OECD G.L. 203 and be non-bioaccumulating. The fluid shall be published under US EPA Environmental Technology Verification (ETV) requirements and tested for compatibility with transformer components. The fluid shall be Factory Mutual Approved, UL® Classified Dielectric Medium (UL-EOUV) and UL Classified Transformer Fluid (UL-EOVK), Envirotemp® FR3® fluid.

3. Tank and Cabinet Enclosure
    a. The high-voltage and low-voltage compartments, separated by a metal barrier, shall be located side-by-side on one side of the transformer tank. When viewed from the front, the low-voltage compartment shall be on the right. Each compartment shall have a door that is constructed so as to provide access to the high-voltage compartment only after the door to the low-voltage compartment has been opened. There shall be one or more additional fastening devices that must be removed before the high-voltage door can be opened. Where the low-voltage compartment door is of a flat panel design, the compartment door shall have three-point latching with a handle provided for a locking device. Hinge pins and associated barrels shall be constructed of corrosion-resistant material, passivated AISI Type 304 or the equivalent.
    b. A recessed, captive, penta-head or hex-head bolt that meets the dimensions per ANSI C57.12.28 shall secure all access doors.
    c. The enclosure integrity of the tank and cabinet shall meet the requirements for tamper resistance set forth in ANSI C57.12.28 including but not limited to the pry test, pull test, and wire probe test.
    d. The compartment depth shall be in accordance with C57.12.34, unless additional depth is specified.
    e. The tank base must be designed to allow skidding or rolling in any direction. Lifting provisions shall consist of four lifting lugs welded to the tank.
    f. The tank shall be constructed to withstand 7 psi without permanent deformation, and 15 psi without rupture. The tank shall include a 15 psig pressure relief valve with a minimum flow rate of 35 SCFM.
    g. The tank and cabinet coating shall meet all the requirements of ANSI C57.12.28 including:
        1) Salt Spray Test
        2) Crosshatch Adhesion Test
        3) Humidity Test
        4) Impact Test
        5) Oil Resistance Test
        6) Ultraviolet Accelerated Weathering Test
        7) Abrasion Resistance - Taber Abraser
    h. The exterior of the unit shall be painted ANSI 70 gray in color. The cabinet interior and tank face shall be painted gray for ease of viewing the inside the compartment.

O. The tank shall be complete with an anodized aluminum laser engraved nameplate. This nameplate shall meet Nameplate B per ANSI C57.12.00.

P. Accessories:
1. Drain Valve: 1 inch, with sampling device.
2. Dial-type thermometer.
3. Liquid-level gage.
4. Pressure-vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.
6. Mounting provisions for low-voltage current transformers.
7. Mounting provisions for low-voltage potential transformers.

2.03 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."

2.04 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90.

B. Factory Tests: Perform the following factory-certified tests on each transformer:
   1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
   2. Ratios on rated-voltage connection and on tap extreme connections.
   3. Polarity and phase relation on rated-voltage connection.
   4. No-load loss at rated voltage on rated-voltage connection.
   5. Excitation current at rated voltage on rated-voltage connection.
   6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
   7. Applied potential.
   8. Induced potential.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.

B. Examine roughing-in of conduits and grounding systems to verify the following:
   1. Wiring entries comply with layout requirements.
   2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

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 that 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.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install transformers on concrete bases.
   1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
   2. Construct concrete bases of dimensions not less than 4 inches larger in both directions than supported unit and 6 inches high.
   3. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and the CEC.

3.03 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

3.04 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
   2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

C. Test Reports: Prepare written reports 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 actions taken to achieve compliance with requirements.

END OF SECTION

SECTION 262200

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.03 ACTION SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, vibration isolation devices, and performance for each type and size of transformer indicated.

B. For vibration isolation devices with integral seismic restraints, include supporting calculations signed by a registered structural engineer or submit an OSHPD pre-approved detail.

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.
   1. Wiring Diagrams: Power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

A. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control test reports.

C. Field quality-control test reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.06 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 the California Electrical Code, CEC, 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."

1.07 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.

1.08 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

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D type transformer or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here:
   1. Eaton Electrical Inc.; Cutler-Hammer Products.
   2. General Electric Company.
   3. Siemens Energy & Automation, Inc.

2.02 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: Aluminum.

D. Nominal System Voltages:
   1. Primary voltage 480V 3 phase, delta connected, unless noted otherwise.
   2. Secondary voltage 208/120 volts, 3 phase, wye connected, unless noted otherwise.

2.03 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Cores: One leg per phase.

D. Enclosure: Ventilated, NEMA 250, Type 2 for indoor transformers.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Enclosure: Ventilated, NEMA 250, Type 3R for outdoor transformers.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: Gray.

G. Transformer Taps:
   1. Taps for Transformers Smaller Than 3 kVA: None.
   2. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.
   3. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

I. 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.
   3. Label in accordance with NEMA TP 3 requirements.

J. Low Sound-Level Requirements: Shall not exceed NEMA ST20 standard sound levels when factory tested according to IEEE C57.12.91.
   1. 9 kVA and Less: 40 dba.
   2. 30 to 50 kVA: 45 dBA.
   3. 51 to 150 kVA: 50 dBA.
   4. 151 to 300 kVA: 55 dBA.
   5. 301 to 500 kVA: 60 dBA.
   6. 501 to 750 kVA: 62 dBA.
   7. 751 to 1000 kVA: 64 dBA.

2.04 VIBRATION ISOLATION DEVICES

A. Manufacturer: Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries products specified herein or a comparable product by one of the following:
   1. Korfund Company
   2. Amber-Booth Company
   3. Consolidated Kinetics Corporation
   4. M.W. Sausse.

B. All isolation devices shall be designed for the equipment with which they will be used. Materials used shall retain their isolation characteristics for the life of the equipment served. All elastomeric materials shall be industrial grade neoprene. Isolation devices subject to weather shall have hot dipped galvanized finish.

C. Type 5 Mounts: Two layers of 0.75 inches thick Mason type Super W neoprene pads pads separated horizontally by a 16 gauge galvanized shim.

D. Type 6 Hangers: Mason type PC30N, vibration hangers similar to type 5, but pre-compressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. Design hangers with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load.

2.05 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."

2.06 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.01 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 the CEC and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 VIBRATION ISOLATION APPLICATION

A. Use type 5 mounts for transformers installed on concrete slabs and where supports and attachments must meet seismic forces defined in ASCE 7-05.

B. Use type 6 hangers for suspended transformers where supports and attachments must meet seismic forces defined in ASCE 7-05.

3.03 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

B. Set transformers plumb and level.

C. Install vibration isolation devices according to Manufacturer’s written instructions.

D. Suspended transformers shall be coordinated with structure with hangers sized to handle transformer physical weight.

E. Maintain a minimum distance of 6 inches from transformer enclosure to adjacent surfaces and equipment.

F. Provide 4 inch high concrete pad for all floor or grade mounted transformers.

3.04 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform visual and mechanical inspection and electrical tests. Test procedures and values shall be in accordance with NETA-2007 requirements. Certify compliance with test parameters.
   2. Compare equipment nameplate data with drawings and specifications.
   3. Inspect physical and mechanical condition, anchorage, alignment, and grounding
   4. Verify that resilient mounts are free and that any shipping brackets have been removed.
   5. Verify the unit is clean.

6. Inspect bolted electrical connections for high resistance
    a. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA-2007, Table 100.12.
    b. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
7. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage in accordance with manufacturer's published data or in the absence of manufacturer's published data, use NETA-2007, Table 100.5.
8. Verify correct secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.

B. Remove and replace units that do not pass tests or inspections and retest as specified above.

C. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

D. Any transformers deemed to be noisy by Engineer shall have actual dB level of transformer verified by manufacturer. Any transformer exceeding NEMA standard sound levels shall be replaced.

3.06 ADJUSTING

A. 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 voltage readings and tap settings as test results.

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 voltages and tap settings.

3.07 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 262413

SWITCHBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Service and distribution switchboards rated 600 V and less.
   2. Disconnecting and overcurrent protective devices.
   3. Instrumentation.
   4. Control power.
   5. Accessory components and features.
   6. Identification.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.
   1. Include dimensioned plans, elevations, sections, conduit entrances, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Detail short-circuit current rating of switchboards and overcurrent protective devices indicating that the devices are fully rated (series rated devices are not allowed)
   5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
   6. Include evidence of listing for fully rating of installed devices.
   7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   8. Submit a coordination study in conjunction with switchgear. Switchgear shop drawings will not be approved until the coordination study is reviewed, approved, and in compliance with the requirements of Division 26 Specification 260573 System Studies.
   9. Include schematic and wiring diagrams for power, signal, and control wiring.

1.04 INFORMATION SUBMITTALS

A. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field Quality-Control Reports:
   1. Test procedures used.

2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards 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. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 2.

E. Comply with California Electric Code (CEC).

F. Comply with UL 891.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Lift using manufacturer supplied attachments.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.08 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:
1. Do not deliver or install switchboards until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

1.09 COORDINATION

A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

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. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   2. Indicating Lights: Equal to 10 percent of quantity installed for each size and type, but no fewer than one of each size and type.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide switchboards comparable to Square D QED Style Switchboards or comparable product by one of the following manufacturers. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.

B. Front-Connected, Front-Accessible Switchboards:
   1. Main Devices: Fixed, individually mounted.
   2. Branch Devices: Panel mounted.
   3. Sections front and rear aligned.

C. Nominal System Voltage: as indicated on the drawings.

D. Main-Bus Continuous: Ampacities and short circuit ratings as indicated on the drawings.

E. Each switchboard, as a complete unit, including service circuit breaker, shall be given a single withstand circuit rating by the manufacturer. The withstand short circuit rating shall certify that all equipment is capable of withstanding the stress of a fault equal to the interrupting rating of the least overcurrent protective device contained herein. Such rating shall be established by actual tests by the manufacturer on equipment constructed similarly to the subject switchboard. The test data shall be available and shall be furnished to the engineer. The short circuit current rating shall be 50 KA RMS symmetrical amperes, minimum, unless otherwise noted on panel schedules. Busing shall be copper.

F. Indoor Enclosures: Steel, NEMA 250, Type 1.
   1. The switchboard framework shall consist of steel channels welded or bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting. The framework is to be formed, code gauge steel, rigidly welded and bolted together to support all coverplates, bussing, and component devices during shipping and installation.
   2. Each switchboard section shall have an individual removable plate for installation and termination of conduit. The wireway front covers are to be hinged to permit access to the fusible switches load side terminals without removing the covers. All front plates used for mounting meters, selector switches, or other front mounted devices shall be hinged with all wiring installed and laced with flexibility on the hinged side. All closure plates shall be screw removable. The paint finish shall be gray enamel over a rust-inhibiting phosphate primer.
   3. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

G. Barriers: Between adjacent switchboard sections.

H. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

I. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

J. Buses and Connections: Three phase, four wire unless otherwise indicated.
   1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, tin-plated with tin-plated aluminum or copper feeder circuit-breaker line connections. The bussing shall be of sufficient cross-sectional area to continuously conduct rated full load current and meet UL Standard 891 temperature rise requirements.
   2. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical type connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
   3. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
   4. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical type connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
   5. The bus bars shall be rigidly braced to comply with the integrated rating of the switchboard.
   6. The main horizontal bus bars between sections shall be located at the back of the switchboard to permit a maximum of available conduit area. The horizontal bus bar supports, connections and joints are to be bolted with grade 5 carriage bolts and Belleville washers to minimize maintenance requirements.

K. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.02 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Where required to achieve system coordination with upstream and downstream overcurrent devices, solid-state, electronic trip, circuit breakers shall be provided and where noted on drawings and schedules.
   2. 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.
   3. Solid State, electronic trip circuit breakers 100% rated, full function, with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I2t response. Ground fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted. Provide ground fault only where indicated on drawings.
      e. Overload and short-circuit and ground-fault trip indicators shall be provided.
   4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Circuit breakers shall be equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large permanent, individual circuit numbers shall be affixed to each breaker in a uniform position (or equip each breaker with a circuit card holder and neatly printed card identifying the circuit). Tripped indication shall be clearly shown by the breaker handle taking a position between ON and OFF. A trip button shall be provided for mechanically tripping the circuit breaker. This allows maintenance checks on the breaker, control circuits, alarm devices, and other associated equipment.
   c. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material
   d. Provide the following where noted on the drawings or schedules:
      1) Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
      2) Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
      3) Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
      4) Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
      5) Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
      6) Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

B. Insulated-Case Circuit Breaker (ICCB): [**80**] [**100**] percent rated, sealed, insulated-case power circuit breaker with interrupting capacity rating to meet available fault current.
   1. Drawout circuit-breaker mounting.
   2. Two-step, stored-energy closing.
   3. Full-function, microprocessor-based trip units with interchangeable rating plug, trip indicators, and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time time adjustments.
      c. Ground-fault pickup level, time delay, and I^2t response.
   4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
   5. Remote trip indication and control.
   6. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
   7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
   8. Control Voltage: 120-V ac.

2.03 INSTRUMENTATION

A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

B. Shall be Square D Power Logic circuit monitor Model PM820 with digital display and the following features.
   1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
      a. Phase Currents, Each Phase: Plus or minus 1 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
d. Megawatts: Plus or minus 2 percent.
e. Megavars: Plus or minus 2 percent.
f. Power Factor: Plus or minus 2 percent.
g. Frequency: Plus or minus 0.5 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.

2. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.
3. Ethernet communications card Square D Power Logic Model PM8ECC.

2.04 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

B. Provisions for future breakers. Provisions for future breakers shall be such that no additional connectors will be required to add breakers.

C. Overhead Circuit-Breaker Lifting Device: Mounted at top front of switchboard, with hoist and lifting yokes matching each drawout circuit breaker.

2.05 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Verify service details with the utility prior to submitting bid.

3.02 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1, in accordance with manufacturer’s written instructions, and in accordance with recognized industry practices.

B. Equipment Mounting: Install switchboards on concrete bases complying with Division 26 Section "Common Work Results for Electrical."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures.

Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Install filler plates in unused spaces of panel-mounted sections.

G. Install overcurrent protective devices, and instrumentation.
   1. Set field-adjustable switches and circuit-breaker trip ranges in accordance with coordination study.

H. Comply with NECA 1.

3.03 CONNECTIONS

A. All conductors and bus connections shall be torqued to manufacturer's connections.

3.04 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting, and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.05 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:
   1. Test insulation resistance for each switchboard bus section, (phase-to-phase and phase-to-ground), component, connecting supply, feeder, and control circuit in accordance with latest version of the NETA Acceptance Testing Specification Chapter 7.
   2. Test continuity of each circuit.
   3. Perform field test prior to energization

B. 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. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

C. Switchboard will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTMENT AND CLEANING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer. Ensure free mechanical movement may occur.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Tighten Bus connections and mechanical fasteners.

D. Touch-up paint shall be applied to scratched or marred surfaces to match original finish.

E. Clean interior of switchboard of all dirt and debris.

3.07 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 262416

PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
   3. Disconnecting and Overcurrent Protective Devices

1.03 ACTION SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective devices, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and electrical ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.
   7. Submit a coordination study in conjunction with panelboards. Switchgear shop drawings will not be approved until the coordination study is reviewed, approved, and in compliance with the requirements of Division 26 Section ”Fault Current and Overcurrent Protective Device Coordination Study".
   8. Field quality control test results
   9. Operating and Maintenance data.

1.04 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.
   3. Copies of all panelboard typewritten directories.

B. Record Drawings: Create and submit record drawings including the final version of each panel schedule after load balancing. Create drawings matching the record set and incorporate final panel schedules on drawing and add panel schedule sheets to drawing index.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in California Electric Code (CEC), by a qualified testing agency, and marked for intended location and application.

C. Comply with National Electrical Manufacturer’s Association (NEMA) Standards Publication Number PB1.1 and PB 1.2.

D. Comply with NEMA PB 1.

E. Comply with the CEC.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards.

B. Do not store panelboards exposed to weather.

C. Handle and prepare panelboards for installation according to NEMA PB 1.

D. Protect panelboards against damage from work of other trades.

1.08 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet.

1.09 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces.

Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with freestanding panelboards with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

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.
   2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: spares for each panelboard as shown on one the Panel Schedules.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials; design and construction in accordance with published product information; equip with proper number of unit panelboard devices as required for complete installation. Where types, sizes or ratings are not indicated, comply with NEC, UL and established industry standards for those applications indicated. Provide circuit directory in clear plastic cover. Provide panelboards with lugs suitable for termination of feeder sizes indicated on drawings.

B. Each panelboard, as complete unit, shall have a short circuit current rating equal to or great than the integrated equipment rating shown on the panelboard schedule. This rating shall be established by testing with the overcurrent devices mounted in the panelboard. Panelboards shall be marked with their maximum short circuit current rating at the supply voltage. All panelboards shall be fully rated, series rated panels are not approved.

C. Enclosures: Flush and surface mounted cabinets. Refer to panel schedule and floor plans for types of panel cabinets required.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, type 1.
      b. Outdoor Locations: NEMA 250, Type 4X, Stainless Steel.
      c. Kitchen and 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 12.
      f. Exterior Corrosive Locations: NEMA 250, type 4X, stainless steel. Refer to drawings for identification of corrosive areas.
      g. Interior Corrosive Locations: NEMA 250, type 4X, fiberglass. Refer to drawing for identification of corrosive areas.
   2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Provide full height hinged trim integrated into front cover to allow access to wire gutters without the removal of cover. Provide hinged door for access to overcurrent devices.
   3. Back Boxes: Galvanized steel.
   4. Directory Card: Inside panelboard door, mounted in transparent card holder.

D. Incoming Mains Location: Top or bottom. Mains location is at the contactor's option as project conditions dictate, unless specifically indicated otherwise on the drawings.

E. Phase, Neutral, and Ground Buses:
   1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

F. 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. Lugs shall be of sizes as required to accept feeders as indicated on the drawings.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Compression 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.

G. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

H. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series rated panels are not approved.

2.02 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D I-Line type distribution panelboards or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.

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 or main lugs only as indicated on the Panel Schedules.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger than 125 A: Bolt-on circuit breakers or plug-in circuit breakers, where individual positive-locking device requires mechanical release for removal.

G. Buses:
1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs. Provide on panels where specifically noted on the panel schedules or one line diagram.

2. Copper equipment and isolated ground buses. Provide on panels where specifically noted on the panel schedules or one line diagram.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D NQOD or NF series panelboards or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or main lugs only as indicated on the on the Panel Schedules.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Buses:
   1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs. Provide on panels where specifically noted on the panel schedules or one line diagram.
   2. Copper equipment and isolated ground buses. Provide on panels where specifically noted on the panel schedules or one line diagram.

F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Where required to achieve system coordination with upstream and downstream overcurrent devices, solid-state, electronic trip, circuit breakers shall be provided and where noted on drawings and schedules.
   2. 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.
   3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   4. Solid State, electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time delay, and I^2t response.
   5. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
   6. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor materials.
   c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
9. Provide the following where noted on the drawings or schedules:
   a. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
   b. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
   c. Lockable: Fixed attachment for padlocking circuit breaker handle in on or off position.

PART 3 - EXECUTION

3.01 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.

3.02 INSTALLATION

A. Install panelboards and accessories according to manufacturer's written instructions, according to NEMA PB 1.1, and in accordance with recognized industry standards.

B. Mount panelboards recessed within a wall or surface mounted as indicated on drawings and schedules.

C. Support panel cabinets independently to structure with no weight bearing on conduits.

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

E. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

F. Mount so that top breaker is not higher than 6'-0" AFF, unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush and tight with wall finish and mating with back box.

H. Adjacent panel cabinets shall be of same physical size and mounted in horizontal alignment.

I. Provide lugs in panelboards of adequate size to accept feeders as indicated on drawings.

J. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.
   2. Install filler plates in unused spaces.
   3. Provide handle clamp accessory for any circuit breaker serving fire alarm control panels or fire alarm power supplies.
   4. Provide lockable handle padlock circuit breaker attachment where noted on panel schedules or plans as lockable option.

K. Provide one ¾" empty conduit for each three panel spaces between panelboard and accessible ceiling space or space designated to be ceiling space in the future, for future use**.**

L. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Verify actual room names and numbers to be used, and include room name, room number and name of load being served for every circuit.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
   2. Megger check and test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit. Do not megger check solid state components.
   3. Test continuity of each circuit.
   4. Energize each circuit and check for complete function.
   5. Set adjustable trip circuit breakers in accordance with coordination study.

B. Panelboards will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Touch up paint scratched or marred surfaces to match original finish.

3.05 ADJUSTING AND CLEANING

A. Adjust moving parts and operable component to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 10 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Tighten lugs and bus connections.

E. Clean interior of panelboard.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 262726

WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. 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. Isolated-ground receptacles.
   5. Snap switches and wall-box dimmers.
   6. Solid-state fan speed controls.

1.03 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. RFI: Radio-frequency interference.

C. TVSS: Transient voltage surge suppressor.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.08 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 unless noted otherwise.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, California Electrical Code, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with the California Electrical Code (CEC).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   2. Leviton Mfg. Company Inc. (Leviton).
   3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.02 DEVICE COLORS

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: As selected by Architect and so as to match surrounding finish as closely as possible, unless otherwise indicated or required by CEC or device listing.
   2. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

2.03 STRAIGHT BLADE RECEPTACLES

A. General:
   1. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498, and FS W-C-596.

B. Heavy-Duty, Simplex:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour – 5361
      b. Hubbell –HBL5361
      c. Leviton - 5361

C. Heavy-Duty Duplex:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour – 5362
      b. Hubbell – HBL5362
      c. Leviton - 5362

D. GFCI Receptacles:
   1. 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.
   2. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
      a. Receptacle shall be capable of being installed in a 2-1/2 inch deep outlet box without adapter.
      b. Shall be grounding type with solid-state ground fault sensing and signaling; with 5 milliamperes ground fault trip level.
      c. Test and reset buttons shall match color of face.
      d. If critical components within receptacle are damaged and the ground fault protection is lost, power to receptacle shall be automatically disconnected within the device.
   3. Products: Subject to compliance with requirements, provide one of the following:
      a. Indoor – Dry Locations:
         1) Pass & Seymour – 2095
         2) Hubbell – GF20-LA
         3) Leviton – 8899
      b. Outdoor and Damp/Wet Locations:
         1) Pass & Seymour – 2095TRWR
         2) Hubbell – GFR5362-SG
         3) Leviton – W7899

E. Isolated Ground Receptacles:
   1. Straight blade, Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   2. Device color shall match non isolated ground receptacles and have an orange triangle on the device.
   3. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour
      b. IG6300
      c. Hubbell – IG5380
      d. Leviton – IG5362
   4. 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.

F. Special Purpose Receptacle:
   1. Manufacturer: Same as general purpose receptacle.
   2. Configuration as shown on Drawings.

2.04 SWITCHES

A. General:

B. Switches shall be rated for 20 amperes, and rated 120/277 volts AC. Switch shall be manufacturer's specification grade toggle switch. Switches shall have quiet action mechanism with silver alloy contacts for longevity. Comply with NEMA WD 1, UL 20, and FS W-S-896.
   1. Terminal screws shall allow back and side wiring and accept #14, 12, and 10 AWG stranded or solid wire.

C. Single Pole
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour – PS20AC1
      b. Hubbell – HBL1221
      c. Leviton – 1221-2

D. Double Pole Single Throw:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour – PS20AC2
      b. Hubbell – HBL1222
      c. Leviton – 1222-2

E. Three Way:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour – PS20AC3
      b. Hubbell – HBL1223
      c. Leviton – 1223-2

F. Four Way:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Pass & Seymour – PS20AC4
      b. Hubbell – HBL1224
      c. Leviton – 1224-2

G. Key Switch Locking - Same series devices as above with –L option.

H. Indicator Light – Separate pilot strap, red color.

I. Locator Light – Lighted handle type switch, green color handle.

2.05 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.
   1. Continuously adjustable slider, 6A.
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. Shall be Lutron type NFS series.

2.06 WIRING DEVICE ACCESSORIES

A. Wall Plates:
   1. Provide wall plates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates; wall plates colored to match wiring devices. Provide plates possessing the following additional construction features:
      a. Material and Finish:
         1) Stainless Steel (0.04 inch thick type 302 satin finished) in all back of house areas subject to physical damage including but not limited to equipment rooms, storage rooms and kitchens.
         2) Nylon, smooth – color to match device in all back of house areas not subject to physical damage such as offices as well as all front of house areas exposed to guest view.
   2. Device plates for surface mounted Type FS or FD boxes: Type FSK galvanized steel covers.
   3. Device plates for surface mounted, 4 in. square boxes: 1/2 in. raised galvanized steel covers.

B. Weatherproof Covers:
   1. Weatherproof covers for all 125-250 volt, 15 and 20 ampere receptacles installed outdoors or in a wet location shall be weatherproof, NEMA 3R, with hinged outlet enclosure rated for rain proof protection while outlet is in use. The unit shall be furnished with a neoprene gasket between the mounting surface and the enclosure, and between the mounting plate and the hinged cover to assure proper seal.
      a. Surface Mounted Type: shall be equal to Intermatic, Die Cast with GFCI mounting plate horizontal mount (duplex), WP1010HMC, vertical mount (quad), WP1030MC.
      b. Recessed/Flush Mounted Type: Shall be Arlington Industries Catalog# DBVM1W with metal backbox.
   2. Weatherproof covers for all free standing outdoor receptacles shall be installed in a 19.5”, low-profile enclosure with built in while in use cover. Shall be bronze in color equal to Arlington Industries GPD19BR.
   3. Weatherproof covers for all other receptacles shall be cast aluminum with a gasketed cover. Shall be equal to Hubbell CWP26H (standard flush box) or Hubbell WPFS26 (surface FS box).
      Weatherproof covers for switches shall be lever switch type, rugged metallic construction with gasketed cover . Shall be equal to Hubbell-Raco 5121 (single switch), Hubbell-Raco 5124 (two ganged switches), Hubbell-Raco 5126 (three ganged switches).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

B. 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 CEC, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.
   d. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

C. Device Installation:
1. Clean debris from every outlet box; including excess drywall mud.
2. 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.
3. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
4. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment. Clean exposed surfaces to remove spatters and restore finish.
5. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
6. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
7. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
8. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
9. Tighten unused terminal screws on the device.
10. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact. Provide extension rings to bring device flush with finished surface (do not use switch box extension rings/goof rings). Install devices plumb, level and rigidly in place.

D. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

E. Device Plates:
1. 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.

F. 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.
4. Verify dimmers achieve full rating of specified/designed load indicated after derating for ganging as instructed by manufacturer.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates where devices permit.

H. All exterior receptacles shall be GFCI type mounted in weatherproof boxes.

I. Ground receptacles with the insulated green ground wire from device ground screw to a bolted outlet box connection. Isolated ground receptacles shall have the second ground wire (green with yellow tracer) ground the receptacle**.**

J. This Contractor shall check the switch location against the Architectural plans and shop drawings to be certain that switches are on the strike side of the door, regardless of swing shown on drawings. Edge of plate shall be not more than 12" from door frame.

K. Install emergency switches which occur adjacent to normal light switches in separate boxes to maintain system's isolation in accordance with CEC required separation.

L. Ground-fault circuit interrupter type receptacles may provide GFCI protection for downstream receptacles on same circuit only where located in same room as other receptacles.

3.02 IDENTIFICATION

A. Comply with Division 16 Section "Identification for Electrical Systems."
   1. Receptacles: Identify panelboard and circuit number from which served on device.

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Test Instruments: Use instruments that comply with UL 1436.
   2. Provide operational testing for devices.
   3. Test receptacles with Hubbell 5200, Woodhead 1750, or equal, for correct polarity, proper ground connection, and wiring faults.

B. Wiring device will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION

SECTION 262813

FUSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches and enclosed controllers.
   2. Plug fuses rated 125-V ac and less for use in plug-fuse-type enclosed switches.
   3. Spare-fuse cabinets.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
   1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

1.04 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.05 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 the California Electrical Code (CEC), by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with the California Electrical Code (CEC).

E. Comply with UL 248-11 for plug fuses.

1.06 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.07 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Edison Fuse, Inc.
   3. Ferraz Shawmut, Inc.
   4. Littelfuse, Inc.

2.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.03 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
   1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
   2. Finish: Gray, baked enamel.
   3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
   4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.01 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.

3.02 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Service Entrance: Class L, time delay.
   2. Motor Branch Circuits: Class RK5, time delay.
   3. Control Circuits: Class CC, fast acting.

3.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is easily readable without removing fuse.

B. Install spare-fuse cabinet(s) in each electrical room serving fused equipment.

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 16 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 262816

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Fusible switches.
   2. Non-fusible switches.
   3. Molded-case circuit breakers (MCCB's).
   4. Molded-case switches.
   5. Enclosures.

1.03 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.04 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to [**ASCE/SEI 7**].
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS

A. 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.

B. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: Two for each size and type.

1.09 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in California Electrical Code (CEC), by a qualified testing agency, and marked for intended location and application.

C. Comply with the CEC.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
   2. Altitude: Not exceeding 6600 feet.

1.11 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D HD series switches or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 240 and 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. 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. Hookstick Handle: Allows use of a hookstick 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.

2.02 NON-FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D HD series switches or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.

B. Type HD, Heavy Duty, Single Throw, 240 and 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. 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. Hookstick Handle: Allows use of a hookstick to operate the handle.
   6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 MOLDED-CASE CIRCUIT BREAKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D I-Line Style bolt-on molded case circuit breakers or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents indicated on the drawings.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits in each pole. Adjustable magnetic trip setting for circuit-breaker frame sizes 150 A and larger, adjustable from the front.

D. Construct with over center, trip-free toggle type operating mechanisms with quick make, quick break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position. Provide breakers lugs AL/CU rated. Lugs shall be adequate to accept wire size indicated on the drawings.

E. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

F. 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.

G. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA or more trip and hold below 4mA of ground fault current). One way circuit length shall not exceed 250 feet. If length exceeds 250 feet, notify engineer in writing prior to installing circuit.

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip). Provide as noted on plans and/or panel schedules and for all circuits supplying power to heat trace.

J. Where required to achieve system coordination with upstream and downstream overcurrent devices, solid-state circuit breakers shall be provided. All electronics shall be self-contained and require no external relaying, power supply, or accessories. Printed circuit cards shall be treated to resist moisture absorption, fungus growth, and signal leakage. All electronics shall be housed in an enclosure which provides protection against arcs, magnetic interference, dust, and other contaminants. Solid-sate sensing shall measure true RMS current with error less than one percent on systems with distortions through the 13^{th} harmonic. Peak or average actuating devices are not acceptable. Current sensors shall be toroidal construction, encased in a plastic housing, filled with epoxy to protect against damage and moisture and shall be integrally mounted on the breaker. Where indicated on the drawings, circuit breaker frames shall be rated for 100 percent continuous duty. Circuit breakers shall have tripping features as described below;
   1. Long time current pick up.
   2. Adjustable long time delay.
   3. Short time current pick up.
   4. Adjustable short time delay.
   5. Short time I square times t switch.
   6. Instantaneous current pick up.
   7. Ground fault current pick up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground fault current at the main bonding jumper or ground strap shall not be permitted. Provide ground fault only where indicated on the drawings.
   8. Overload and short circuit and ground fault trip indicators shall be provided.

K. Interrupting ratings shall be as indicated on drawings. Circuit breakers shall be fully rated for available fault current. Series rating is not acceptable.

L. 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. Provide the following where noted on the drawings or schedules:
    a. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered for solid state type trip units and remote-mounted and powered for magnetic type trip units 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.
    b. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

2.04 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 4X, stainless Steel.
3. Kitchen and wash-down areas: NEMA 250, type 4X, stainless steel.
4. Other Wet or Damp Indoor Locations: NEMA 250, type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, type 12.
6. Exterior Corrosive Locations: NEMA 250, type 4X, stainless steel. Refer to drawings for identification of corrosive areas.
7. Interior Corrosive Locations: NEMA 250, type 4X, fiberglass. Refer to drawing for identification of corrosive areas.

PART 3 - EXECUTION

3.01 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.

3.02 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 16 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. Circuit breakers and molded case switches shall be factory installed in enclosures.

F. Comply with NECA 1.

3.03 IDENTIFICATION

A. Comply with requirements in Division 16 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.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

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. 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 reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

F. Test and/or permanently record the following:
   1. Fuses:
      a. Equipment nameplate requirement.
      b. Actual fuse rating.
   2. Circuit Breakers:
      a. Nameplate data.
      b. Actual trip setting.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 16 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION

SECTION 262913

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:
   1. Full-voltage manual.
   2. Full-voltage magnetic.
   3. Reduced-voltage magnetic.
   4. Multispeed.

B. All starters, disconnects, VFCs, relays, pushbuttons, pilot lights, and other devices required for the control of motors or electrical equipment shall be furnished by Division 16, except as specifically noted elsewhere in these specifications.

C. In specific instances where starters and/or disconnects are furnished loose (not integral to equipment) by Division 15 or other Contractor, they shall be installed by Division 16 Contractor, coordinated with Division 15 or other Contractor, and furnished in accordance with Division 16 Sections of the specifications.

D. Related Section:
   1. Division 16 Section "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

1.03 DEFINITIONS

A. CPT: Control power transformer.

B. MCP: Motor circuit protector.

C. N.C.: Normally closed.

D. N.O.: Normally open.

E. OCPD: Overcurrent protective device.

1.04 ACTION 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.

1.05 INFORMATIONAL SUBMITTALS

A. 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.

B. Field quality-control reports.

C. 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.

1.06 CLOSEOUT SUBMITTALS

A. 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.

1.07 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

1.08 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 **the** California Electrical Code (CEC**)**., by a qualified testing agency, and marked for intended location and application.

C. Comply with the CEC.

D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."

1.09 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. Do not store in areas subject to weather.

C. Protect motor starters against damage from work of other trades.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
   2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
   3. Humidity: Less than 95 percent (noncondensing).
   4. Altitude: Not exceeding 6600 feet, or 3300 feet if MCC includes solid-state devices.

1.11 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 features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

D. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D enclosed controllers or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.

2.02 FULL-VOLTAGE MANUAL CONTROLLERS AND SWITCHES

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.

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. Configuration: Nonreversing.
   2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
   3. Red pilot light to indicate motor running.

D. Integral Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
   1. Configuration: Nonreversing, Reversing, and Two speed.
   2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters and sensors in each phase, matched to nameplate full-load current of

actual protected motor and having appropriate adjustment for duty cycle; external reset push button; bimetallic type.
3. Red pilot light to indicate motor running.
4. Additional Nameplates: FORWARD and REVERSE for reversing controllers, HIGH and LOW for two-speed controllers.

2.03 COMBINATION FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Combination Magnetic Controllers: Factory-assembled combination of a full voltage, across the line, electrically held, magnetic controller, OCPD, and disconnecting means.
1. Configuration: Nonreversing and Reversing.
2. Contactor Coils: Pressure-encapsulated type.
   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
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, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   a. Minimum CPT Size: 50VA.
   b. CPT Spare Capacity: 50VA.
5. Solid-State Overload Relay:
   a. Switch or dial selectable for motor running overload protection.
   b. Sensors in each phase.
   c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
6. 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.
7. Short Circuit Rating:
   a. The short circuit current rating of the combination starter shall be the same as the upstream overcurrent protection device protecting the starter.

2.04 COMBINATION REDUCED-VOLTAGE MAGNETIC CONTROLLERS

A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition.

B. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage, electrically held, magnetic controller, OCPD, and disconnecting means.
1. Configuration:
   a. Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.
2. Contactor Coils: Pressure-encapsulated type.
   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
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, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   a. Minimum CPT Size: 50VA.

b. CPT Spare Capacity: 50VA.

5. Solid-State Overload Relay:
   a. Switch or dial selectable for motor running overload protection.
   b. Sensors in each phase.
   c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
6. 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.
7. Short Circuit Rating:
   a. The short circuit current rating of the combination starter shall be the same as the upstream overcurrent protection device protecting the starter.

2.05 COMBINATION MULTISPEED MAGNETIC CONTROLLERS

A. General Requirements for Multispeed Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Combination Multispeed Magnetic Controllers: Factory-assembled combination of two speed, full voltage, across the line, electrically held, magnetic controller, OCPD, and disconnecting means.
   1. Configuration: Nonreversing, separate winding for each speed
   2. Contactor Coils: Pressure-encapsulated type.
      a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
   3. Variable Torque Motors:
      a. For Motors with 2:1 speed ratio, consequent pole, single winding
      b. For motors with other than 2:1 speed ratio, separate winding for each speed
   4. Power Contacts: Totally enclosed, double break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
   5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
      a. Minimum CPT Size: 50VA.
      b. CPT Spare Capacity: 50VA.
   6. Compelling relays shall ensure that motor will start only at low speed.
   7. Solid-State Overload Relay:
      a. Switch or dial selectable for motor running overload protection.
      b. Sensors in each phase.
      c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
   8. 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.
   9. Short Circuit Rating:
      a. The short circuit current rating of the combination starter shall be the same as the upstream overcurrent protection device protecting the starter.

2.06 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
   a. Indoor Dry and Clean Locations: Type 1.
   b. Outdoor Locations: Type 4X, stainless steel.
   c. Kitchen and wash-down areas: Type 4X, stainless steel.
   d. Other Wet or Damp Indoor Locations: Type 4X, stainless steel.

e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: Type 12.
f. Exterior Corrosive Locations: Type 4X, stainless steel. Refer to drawings for identification of corrosive areas.
g. Interior Corrosive Locations: Type 4X, fiberglass. Refer to drawing for identification of corrosive areas.

2.07 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.
a. Pilot Lights: LED types; Red to indicate motor running; push to test.
b. Selector Switches: Rotary type; 3 position (Hand, Off, Automatic).
c. External overload reset push button.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
3. Auxiliary contacts "a" and "b" arranged to activate with MCP handle to disconnect external control power when starter door or cover is opened.
4. N.O. alarm contact that operates only when MCP has tripped.
5. N.O., isolated overload alarm contact.

B. Two N.C. and two N.O. auxiliary contact(s).

C. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

E. Cover gaskets for Type 1 enclosures.

PART 3 - EXECUTION

3.01 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.

3.02 INSTALLATION

A. Manual Controllers: Flush mount in wall

B. 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 16 Section "Hangers and Supports for Electrical Systems."

C. Floor-Mounted Controllers: Install enclosed controllers on concrete bases complying with Division 16 Section "Common Work Results for Electrical."

D. Seismic Bracing: Comply with requirements specified in Division 16 Section "Vibration and Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 16 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.

3.04 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Division 16 Section "Low-Voltage Electrical Power Conductors Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control selection devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
   2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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 MCC section, (phase-to-phase and phase-to-ground), component, enclosed controller, component, connecting supply, feeder, and control circuit in accordance with the latest version of the NETA Acceptance Testing Specification Chapter 7.
   2. Test continuity of each circuit.

D. 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 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect and 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. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
   9. Mark up a set of manufacturer's drawings with all field modifications incorporated during construction and return to manufacturer for inclusion in Record Drawings.

E. Enclosed controllers will be considered defective if they do not pass tests and inspections.

F. 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.

3.06 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust the trip settings of MCPs with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes 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 Architect and Owner before increasing settings.

C. Set the taps on reduced-voltage autotransformer controllers at 65 percent.

D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid-state controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Division 16 Section "Overcurrent Protective Device Coordination Study."

3.07 PROTECTION

A. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.08 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION

SECTION 262923

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. Specific requirements, i.e., voltage, horsepower, etc., for the VFC shall be as indicated on the drawings.

C. Related Sections:
   1. Division 26 Section "Motor-Control Centers" for VFCs installed in motor-control centers.

D. All VFCs shall be furnished by Division 26, except as specifically noted elsewhere in these specifications.

E. In specific instances where VFCs are furnished loose (not integral to equipment) by Division 23 or other Contractor, they shall be installed by Division 26 Contractor, coordinated with Division 23 or other Contractor, and furnished in accordance with Division 26 Sections of the specifications.

1.03 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. IGBT: Insulated-gate bipolar transistor.

D. LED: Light-emitting diode.

E. PCC: Point of common coupling.

F. PWM: Pulse-width modulated.

G. RFI: Radio-frequency interference.

H. TDD: Total demand (harmonic current) distortion.

I. THD(V): Total harmonic voltage demand.

J. VFC: Variable-frequency motor controller.

1.04 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.05 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.
   1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Enclosure types and details.
      d. Nameplate legends.
      e. Short-circuit current (withstand) rating of complete assembly with documentation substantiating rating indicated. The short circuit rating of the assembly shall be greater than the available fault current of the power supply feeding the VFC assembly.
      f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
      g. Specified modifications.
   2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For VFCs, accessories, and components, from manufacturer.
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

B. Product Certificates: For each VFC, from manufacturer.

C. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels.
   1. Prior to installation, the VFC manufacturer shall provide the estimated total harmonic distortion (THD) caused by the VFC's. The results shall be based on a computer aided circuit simulation of the total actual system, with information obtained from the power service provider and the user.

D. Field quality-control reports.

E. 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.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs 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 thermal-magnetic circuit breaker and MCP trip settings.
   2. Manufacturer's written instructions for setting field-adjustable overload relays.
   3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
   4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
   2. Indicating Lights: Two of each type and color installed.

1.09 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the California Electric Code (CEC), by a qualified testing agency, and marked for intended location and application.

B. Comply with the CEC.

C. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store VFCs in dry, low humidity location prior to installation.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
   2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F
   3. Humidity: Less than 95 percent (noncondensing).
   4. Altitude: Not exceeding 3300 feet.

1.12 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
   1. Torque, speed, and horsepower requirements of the load.
   2. Ratings and characteristics of supply circuit and required control sequence.
   3. Ambient and environmental conditions of installation location.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.13 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.
   2. The warranty shall include parts, labor, travel and all associated living expenses incurred by the manufacturer to provide factory authorized on-site service. The warranty shall be provided by the VFC manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Rockwell Automation; Allen-Bradley Brand.; Industrial Control Group Powerflex Series or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply

automatic approval. It is the sole responsibility of the contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.

1. ABB.
2. Square D; a brand of Schneider Electric.
3. Danfoss Inc.; Danfoss Drives Div.
4. Yaskawa Electric America, Inc; Drives Division.

B. Where VFCs are located in an MCC, then only Rockwell Automation; Allen-Bradly Brand Powerflex Series drives shall be acceptable within the MCC. MCC shall be as manufactured by Allen-Bradley. Refer to Division 26 Section “Motor-Control Centers” for additional information on motor-control center specifications.

C. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

D. Application: Variable torque.

E. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency. The solid state VFC shall employ a full wave rectifier, AC input / output Line Reactors, capacitors, and IGBT’s as the output switching device.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

F. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

G. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

H. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: **[65][100]** kA.
7. Vibration Withstand: Comply with IEC 60068-2-6.
8. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
9. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
10. Speed Regulation: Plus or minus 10 percent.
11. Output Carrier Frequency: Selectable; 0.5 to 8 kHz. In addition, the output carrier frequency shall be randomly modulated about the selected frequency.
12. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

I. Inverter Logic: Microprocessor based, isolated from all power circuits.

J. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

K. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 0.1 to 999.9 seconds.
   4. Deceleration: 0.1 to 999.9 seconds.
   5. Current Limit: 30 to minimum of 150 percent of maximum rating.

L. Self-Protection and Reliability Features:
   1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
   3. Under- and overvoltage trips.
   4. Inverter overcurrent trips.
   5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
   6. Critical frequency rejection, with selectable, adjustable deadbands.
   7. Instantaneous line-to-line and line-to-ground overcurrent trips.
   8. Reverse-phase protection.
   9. Short-circuit protection.
   10. Motor overtemperature fault.
   11. Ground fault.
   12. The VFC and full speed bypass motor control circuitry shall be protected from sustained power or phase loss. This protection shall utilize an under-voltage relay located on the secondary side of the 120 volt AC control power transformer and be set to deactivate all power circuitry if the voltage drops below the safe operating range (95 volts AC) of the mechanical contactors.

M. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

N. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.
   1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
   2. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
   3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

R. NO alarm contact that operates only when circuit breaker has tripped.

S. The drive shall employ a current limit circuit to provide trip free operation and shall have the capability to be set between 40 and 110 percent of the drive controller output. The current limit

shall be able to be set either manually via the keypad, by a frequency level, by a logic input or by an analog input.

T. The VFC shall be optimized for a 4 kHz carrier frequency to reduce motor noise and provide high system efficiency. The carrier frequency shall be adjustable by the start-up engineer or the drive shall have the capability to inject a white noise down the motor leads to reduce motor noise.

U. Galvanic and/or optical isolation shall be provided between the drive's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. Drives not including isolation on both analog I/O and discreet I/O shall include additional isolation modules as manufactured by Action Instruments, Inc.

V. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of emergency stop signals for: freeze, fire, smoke contacts, external start command and run status contact. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in Hand, Auto or Bypass.

W. Door interlocked circuit breaker disconnect switch which will disconnect all input power from the drive and all internally mounted options. The disconnect handle shall be thru-the-door type, and be padlockable in the "Off" position.

2.02 CONTROLS AND INDICATION

A. Panel-Mounted, 3-position Hand-Off-Auto Switch: When in "Hand", the VFC will be started, and the speed will be controlled from the speed potentiometer. When in "Off", the VFC will be stopped. When in "Auto", the VFC will start via an external contact closure, and its speed will be controlled via an external speed reference

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Fault or alarming status (code).
   6. Motor output voltage (V ac)
   7. Elapsed Time Meter.
   8. kWh meter.

E. Control Signal Interfaces:
   1. Electric Input Signal Interface:

a. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual (feedback) signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 4 - 20 mA and 0 - 10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.
b. Two (2) programmable digital inputs for maximum flexibility in interfacing with external devices. One dedicated non-programmable digital input is to be utilized as a customer safety connection point for fire, freeze, and smoke interlocks (Enable). The stop mode utilizing this input shall be coast to rest. Upon remote customer reset (reclosure of interlock), drive is to resume normal operation. All safety inputs shall be fully operational in the normal and bypass mode of operation.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
3. Electronic Output Signal Interface:
   a. Two (2) programmable analog outputs proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, or Active Reference.
   b. Two (2) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS. Outputs must be true form C type contacts; open collector outputs are not acceptable.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.
   1. Number of Loops: One.

G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
   1. Network Communications Ports: Ethernet and RS-422/485.
   2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet Johnson Metasys N2 Modbus/Memobus, and FLN; protocols accessible via the communications ports.
   3. Coordinate with DDC temperature control system being furnished for type of protocol to be provided and if different than one of the standard protocols, provide necessary interface module.
   4. As a minimum the following points shall be controlled and/or accessible:
      a. Drive start/stop
      b. Speed set adjustment
      c. Indication of setting of VFC three position selector switch.
      d. Meter points
         1) Motor power in kW or HP
         2) Motor current
         3) Motor frequency/speed

H. Three (3) programmable critical frequency lockout ranges to prevent the VFC from continuously operating at an unstable speed.

I. Four (4) programmable preset speeds.

J. The VFC shall Ramp or Coast to a stop, as selected by the user.

K. For fan and pump applications, the acceleration and deceleration profile shall be an S-curve to avoid abrupt speed changes.

2.03 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

C. The VFC shall have an input AC line reactor that has a minimum of 5% impedance to reduce the harmonics to the power line and to increase the fundamental power factor.

D. The VFC shall have a dv/dt output load reactor to limit the peak voltage generated by the inverter to not greater than 1000 volts at the motor. Shall be provided where used with existing motors or where distance between VFC and motor exceeds 100 feet. Load reactors shall be constructed with IGBT protection and have a 4000 volt rms (5600V peak) insulation dielectric strength and meet UL 506 and UL 508 requirements.
1.

2.04 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Indoor Dry and Clean Locations: Type 1.
2. Outdoor Locations: Type 4x, stainless steel.
3. Kitchen and wash-down areas: Type 4X, stainless steel.
4. Other Wet or Damp Indoor Locations: Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: Type 12.
6. Exterior Corrosive Locations: Type 4X, stainless steel. Refer to drawings for identification of corrosive areas.
7. Interior Corrosive Locations: Type 4X, fiberglass. Refer to drawing for identification of corrosive areas.

2.05 ACCESSORIES

A. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4, Type 4X, and Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

B. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with intake and exhaust grills and filters; 120 -V ac; obtained from integral CPT.

C. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.06 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

3.03 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Floor-Mounting Controllers: Install VFCs on concrete bases complying with Division 26 Section "Common Work Results for Electrical."

D. The contractor shall complete all wiring in accordance with the recommendations of the VFC manufacturer as outlined in the installation manual. Power wiring shall be installed in metal conduit from the drive to the motor.

E. Where a remote disconnect at the motor is provided for a motor controlled by an adjustable frequency drive, coordinate with the supplier of the disconnects to ensure that a late make, early break auxiliary contact rated for ten amps continuous duty is provided on the disconnect. This auxiliary contact shall be wired into the VFC emergency shutdown (coast to stop) circuit to ensure shutdown of the VFC in the event of the remote disconnect being opened. Damages resulting from equipment failures due to omission of this safety device shall be the responsibility of the Contractor providing the VFC. Provide the required control wiring between the disconnect switch and VFC.

F. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

H. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

3.04 STARTUP SERVICE

A. The manufacturer shall provide start-up commissioning of the VFC and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer's site. Sales personnel and other agents who are not factory certified technicians for VFC field repair shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFC, its options and its interface wiring to the building automation system. Include a copy of the Start-Up Report in the close-out documents. Manufacturer shall provide a minimum of one trip for every four (4) VFC's.

B. The start-up report shall include the following information in addition to the manufacturer's standard information:
   1. BAS (Building Automation System) input signals and ranges.
   2. Low speed limit points as defined by BAS or the fan and pump manufacturer's representative.
   3. Motor amp and kW at low limit and high limit speeds.
   4. Acceleration and deceleration settings.

3.05 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set the taps on reduced-voltage autotransformer controllers.

C. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

D. Set field-adjustable pressure switches.

3.06 PROTECTION

A. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs at the time of the equipment commissioning.

END OF SECTION

SECTION 263111

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM (EXISTING SYSTEM)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 REFERENCE CODES AND LISTINGS

A. National Fire Protection Association (NFPA) – The latest adopted edition of the code referenced:
   1. NFPA 1 – National Fire Code
   2. NFPA 13 – Standard for the Installation of Sprinkler Systems
   3. California Electrical Code (CEC)
   4. NFPA 72 – National Fire Alarm Code
   5. NFPA 90A – Standard for the Installation of Air Conditioning and Ventilating Systems
   6. NFPA 101 – Life Safety Code

B. Federal Guidelines for Accessibility for Americans with Disabilities

C. ASME 17.1 Elevator Code

D. California Building Code.

E. Approval from the Office of the State Fire Marshal.

F. The system as a whole and the individual system components shall comply with applicable listings of Underwriter's Laboratories (UL), including but not limited to the following.
   1. UL864/UOJZ, APOU – Control Units for Fire Protective Signaling Systems
   2. UL 268A – Smoke Detectors for Fire Protective Signaling Systems
   3. UL268A – Smoke Detectors for Duct Applications
   4. UL 228 – Door Holders for Fire Protective Signaling Systems
   5. UL 464 – Audible Signaling Appliances
   6. UL 1638 – Visual Signaling Appliances
   7. UL 38 – Manually Activated Signaling Boxes
   8. UL 346 – Water flow Indicators for Fire Protective Signaling Systems
   9. UL 1971 – Standard for Signaling Devices for the Hearing Impaired
   10. UL 1481 – Power Supplies for Fire Protective Signaling Systems
   11. UL 521 – Heat Detectors for Fire Protective Signaling Systems

1.03 SUMMARY

A. Section Includes:
   1. Manual fire alarm pull stations.
   2. System smoke detectors.
   3. Non-system smoke detectors.
   4. Intelligent addressable heat detectors.
   5. Notification devices.
   6. Air handling system shutdown relays
   7. Addressable interface devices
   8. Water flow detector pressure switches
   9. Sprinkler supervisory switches
   10. Device guards

B. Related Sections include the following:
   1. Division 26 Section "Low-Voltage Electrical Power Conductors and Cables"
   2. Division 26 Section "Grounding and Bonding for Electrical Systems"

3. Division 26 Section “Raceways and Boxes for Electrical Systems”
4. Division 26 Section "Seismic Restraint For Electrical Systems" for requirements necessary for compliance with seismic criteria.

1.04 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.05 SYSTEM DESCRIPTION

A. The existing addressable fire alarm system shall be extended as indicated on the drawings and described herein.

B. Contractor shall verify adequacy of system battery and power supply capacity to serve new system devices. Contractor shall provide additional battery and power supply capacity, if required, to support new devices being added to system.

C. New devices shall be connected to existing system such that existing function and operation of system is maintained.

D. Where visual alarm notification devices (strobes) are added in an area and there are more than two visual signal devices in field of view, all visual signal devices within field of view (new and existing) shall be synchronized. Contractor shall replace existing strobes and provide the necessary modules in the control unit where necessary to accomplish synchronization.

1.06 ACTION SUBMITTALS

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

B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
2. Include voltage drop calculations for notification appliance circuits.
3. Include 25% spare capacity on each signal circuit so that additional devices can be added.
4. Include substantiating emergency (battery) and normal power supply calculations for supervisory and alarm power requirements and calculations of notification device circuit loading (end of circuit voltage drop) to ensure proper operation of all devices.
5. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
6. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits. Drawing scale shall match engineers design drawings.
7. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
8. Include complete schematic circuit diagrams for system, including all equipment. Wiring diagram shall show point to point connections between all system components
9. Include descriptions of system operation, annunciator schedule showing titles for each zone, and manufacturer’s literature marked to show model and catalog number for all equipment.
10. Include complete riser diagrams for system indicating wiring sequence of all alarm devices and control equipment shall be included with submittal data.

C. General Submittal Requirements:
1. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire-alarm system design.
   b. NICET-certified fire-alarm technician, Level III minimum.

D. Systems Contractor Qualifications.
   1. The contractor directly responsible for this work shall be a systems contractor, who is and who has been regularly engaged in the furnishing and installation of commercial and industrial fire alarm systems of this type and size for at least the immediate past 5 years. All equipment shall be installed by a technician trained by the equipment manufacturer or a recognized training school or course for the installations of this type system. The contractor shall, if requested by the engineer, show proof of a specific individual's training. The system's contractor shall directly employ a suitable number of skilled systems installers whose normal work is systems installation and who shall install and make the wire and cable connections thereto.
   2. As part of the project submittal, it shall be demonstrated to the satisfaction of the engineer that the systems contractor has adequate plant and equipment to do the work properly and expeditiously, adequate staff and technical experience.

1.07 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification: Manufacturer's certification of seismic qualification according to ASCE 7-05. Submit ASCE 7-05 special seismic certification as required. Include method used to determine compliance with requirements.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.08 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
   3. Record copy of site-specific software.
   4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
      a. Frequency of testing of installed components.
      b. Frequency of inspection of installed components.
      c. Requirements and recommendations related to results of maintenance.
      d. Manufacturer's user training manuals.
   5. Manufacturer's required maintenance related to system warranty requirements.
   6. Abbreviated operating instructions for mounting at fire-alarm control unit.
   7. Copy of NFPA 25.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

C. The Contractor shall provide three bound copies of the following, to be forwarded to the Owner at completion of project:

1. As-built wiring and conduit layout diagrams showing all fire alarm devices on floor plans, including wire color code and terminal numbers, and showing all interconnections in the system.
2. Electronic circuit diagrams of all FACP modules, power supplies, annunciator, data gathering panels, addressable interface modules, etc.
3. Technical literature on all major parts of the system, including control panels, smoke detectors, batteries, manual stations, alarm notification appliances, power supplies, and remote alarm transmission means.

1.09 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamper proofed components.
6. Audible and Visual Notification Appliances: Three of each type installed.
7. Fuses: Two of each type installed in the system.

1.10 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. The addressable fire alarm system shall be connected, programmed, and tested only by the manufacturer or by an authorized distributor who stocks a full compliment of spare parts for the system. Technicians performing this service shall be trained and individually certified by the manufacturer for the model of system being installed. Copies of their certifications must be included with the contractor's submittal to the engineer, prior to installation. The submittal cannot be approved without this information.

C. System equipment shall be from a single manufacturer and shall be supported by a manufacturer authorized, established service organization that shall stock parts for the equipment supplied. Components shall be compatible with, and operate as, an extension of the existing fire alarm system.

D. Equipment shall be manufactured by a firm that has been actively manufacturing fire alarm systems for a minimum of 7 years and that offers a 3 year warranty on all control equipment.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

G. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level II technician.

1.11 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Receive equipment at jobsite; verify applicable components and quantity delivered per invoice.

B. Handle equipment to prevent internal components damage, breakage, denting, and scoring enclosure and finish.

C. Do not install damaged equipment.

D. Store equipment in a clean, dry space and protect from dirt, fumes, water, construction debris, and physical damage.

E. After installation, protect from damage by work of other trades.

1.12 PROJECT CONDITIONS

A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
   1. Notify Owner no fewer than two days in advance of proposed interruption of fire-alarm service.
   2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

1.13 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.14 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service:
   1. Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
   2. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.15 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of system and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Manufacturer’s standard warranty period (minimum one year) from date of start-up.
   2. Labor and travel time for necessary repairs at the job site shall be included.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

2.02 EXISTING CONTROL UNIT

1. Provide all required software and reprogramming of the existing control unit for new devices being added to system.

2.03 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
   1. Manual stations.

2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Automatic sprinkler system water flow.
6. Fire-extinguishing system operation.
7. Fire standpipe system.

B. Fire-alarm signal shall initiate the following actions:
1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Activate smoke-control system (smoke management) at firefighter smoke-control system panel.
8. Activate stairwell and elevator-shaft pressurization systems.
9. Close smoke dampers in air ducts of designated air-conditioning duct systems.
10. Activate emergency lighting control.
11. Activate emergency shutoffs for gas and fuel supplies.
12. Record events in the system memory.
13. Record events by the system printer.
14. If fire alarm activation is caused by a duct smoke detector, the following actions shall be initiated:
    a. Shut down associated air handling system.
    b. Close all smoke dampers in ducts associated with the air handling unit.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
2. Sprinkler tamper switches.
3. Low-air-pressure switch of a dry-pipe sprinkler system.
4. Elevator shunt-trip supervision.
5. Provide monitoring of the following fire pump alarms:
    a. Pump running.
    b. Controller connected to alternate power source.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

E. System installation shall allow remote restarting of all air handling systems after having been shut down by the Fire Alarm System. Air handling systems shall automatically restart after fire alarm system has been reset.

F. Smoke dampers in ducts shall close whenever associated air handling system is shut down either by fire alarm system activation or otherwise.

2.04 MANUAL FIRE ALARM PULLSTATIONS

A. Provide manual stations as indicated on drawings. Manual stations shall match existing devices.

2.05 SYSTEM SMOKE DETECTORS

A. Provide smoke detectors as indicated on drawings. Smoke detectors shall match existing devices.

B. Duct smoke detectors.
   1. Duct smoke detectors shall match existing devices. Provide duct housing and sampling tubes extending the entire width of the duct. Provide required control module.
   2. Air handling units shall shut down upon activation of any fire alarm system automatic detection device or sprinkler flow alarm switch.
   3. Provide remote alarm indicator located in corridor ceiling for each air handling system's duct detector.

2.06 INTELLIGENT ADDRESSABLE HEAT DETECTORS

A. Provide heat detectors as indicated on drawings. Heat detectors shall match existing devices.

2.07 NOTIFICATION DEVICES

A. General Requirements for Notification Devices: Connected to notification device signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

B. Visual Notification Devices: Provide visual notification devices as indicated on drawings. Visual notification device shall be a flashing strobe and meet NFPA 71 and ADA requirements. Shall match existing devices. Strobes shall provide a synchronized flash rate.

C. Electronic Chime Notification Devices: Provide electronic chime notification devices as indicated on drawings. Shall match existing devices.

D. Horn Notification Devices: Provide horn notification devices as indicated on drawings. AFF to bottom of strobe. Shall match existing devices.

E. Voice/Tone Speaker Notification Devices: Provide voice/tone speaker notification devices as indicated on drawings. Flush wall mount 80" AFF to bottom of strobe. Shall match existing devices.

F. Audible Alarm Notification Devices (Mini-Horn) – Guest Rooms: Provide audible alarm signal devices as indicated on drawings. Shall match existing devices.

G. Audible Alarm Notification Devices (Mini-Sounder) – Guest Rooms: Provide audible alarm signal devices as indicated on drawings. Shall match existing devices.

H. Combination Audible (horn, speaker, chime, etc) and Visual Notification Devices: Provide combination audible and visual notification devices as indicated on drawings. Visual portion of notification device shall be a flashing strobe and meet NFPA 71 and ADA requirements. Shall match existing devices. Strobes shall provide a synchronized flash rate.

2.08 POWER SUPERVISORY RELAY

A. Provide power supervisory relay modules as required. The relay shall provide one form "C" output for closing or opening circuit on activation. Relay shall be heavy duty rated at 7 amps @ 24 Vdc. A red LED shall be provided to indicate that the relay is energized. Relays shall be flush wall mounted (end of circuit) within junction box behind area pull station or smoke detector.

2.09 AIR HANDLING SYSTEM SHUTDOWN RELAYS

A. Provide and install a supervised addressable output relay at each Air Handling System for shutdown on alarm from fire alarm system as per system operation description. The unit shall be

normally closed with a coil to match voltage of Fire Alarm Control Unit and interrupt starting circuit of Air Handling System unit fan(s). Shall be Air Products Corp. Model PAM-1 and interface with fire alarm manufacturer's control relay module. Provide and install a supervised addressable output relay at each exhaust fan for shutdown on alarm from fire alarm system as per system operation description, unless exhaust fan is interlocked with AHU.

2.10 ADDRESSABLE INTERFACE DEVICES

A. Description: Microelectronic monitor and control modules. Listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts, and for initiating control functions by activating form "C" addressable contacts that are monitored by devices that are to be controlled.

B. The Monitor Module shall be factory set to support one (1) supervised Class B Normally-Open Active Non-Latching Monitor circuit.

C. Single Input Modules. Provide intelligent single input modules as required. The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. The single input module shall support the following circuit types:
   1. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.
   2. Normally-Open Alarm Delayed Latching (Water flow Switches)
   3. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
   4. Normally-Open Active Latching (Supervisory, Tamper Switches).

D. Dual Input Modules. Provide intelligent dual input modules as required. The Dual Input Module shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The dual input module shall support the following circuit types:
   1. Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
   2. Normally-Open Alarm Delayed Latching (Water flow Switches)
   3. Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
   4. Normally-Open Active Latching (Supervisory, Tamper Switches)

E. Provide intelligent control relay modules as required. The control relay module shall provide one form "C" dry relay contact rated at 2 amps @ 24 VDC to control external devices or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.

2.11 WATERFLOW DETECTOR/PRESSURE SWITCHES

A. Water flow or pressure switches to be supplied and installed by the fire protection system contractor and wired to the Fire Alarm System by this Contractor. Provide water flow/tamper module as required.

2.12 SPRINKLER SUPERVISORY SWITCHES

A. Supervisory switches to be supplied and installed by fire protection system contractor and wired to the Fire Alarm System by this Contractor. Activation of switch shall cause supervisory alarm to be displayed at fire alarm control unit. Provide water flow/tamper module as required.

2.13 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
   1. Factory fabricated and furnished by manufacturer of device.
   2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
   1. Connect new equipment to existing control unit in existing part of the building.
   2. Connect new equipment to existing monitoring equipment at the supervising station.
   3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Smoke- or Heat-Detector Spacing:
   1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
   2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
   3. Smooth ceiling spacing shall not exceed **30 feet**.
   4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
   5. HVAC: Locate detectors not closer than **3 feet** from air-supply diffuser or return-air opening.
   6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Provide weatherproof enclosures for any duct smoke detector installed outdoors.

E. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

F. Flush mount all notification devices within walls.

G. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.02 PROGRAMMING

A. A unique identification number shall be assigned to each detector. (Identification shall be by zone number and device number within the zone.) This number shall be noted on the submittals and as-built plans, and also be permanently mounted adjacent to the detector or affixed to its base.

B. Descriptive display of all addressable devices at fire alarm control unit. LCD shall include smoke compartment in which device is located.

3.03 WIRING INSTALLATION

A. Installation of wiring shall comply with NFPA 70, Article 760 and other NFPA 70 requirements. Manufacturer's recommendations for segregation of system wiring in separate raceways and for shielding certain system conductors from other conductors shall be followed, provided these recommendations do not violate NFPA 70. All wiring shall be installed in conduit.

B. All wiring shall be installed in conduit. Flexible connectors shall be used for all devices mounted in suspended lay-in ceiling panels. All conduit, mounting boxes, junction boxes and panels shall be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.

C. Power conductors shall be minimum #12. Both power wires and circuit breaker shall be rated to the current requirements for the system.

D. All junction boxes that are visible or accessible shall be painted red, unless in finished areas. Flexible connectors shall be used for all devices mounted in suspended lay-in ceiling panels. All conduit, mounting boxes, junction boxes and panels shall be securely hung and fastened with appropriate fittings to insure positive grounding throughout the entire system.

E. No wiring other than that directly associated with fire alarm or auxiliary fire protection functions shall be permitted in fire alarm conduits. There shall be NO splices in the system other than at terminal blocks. “Wire nuts” and crimp splices are NOT permitted. Permanent wire markers shall be used to identify all terminations for each circuit. For splices, use markers or other means to indicate which conductor leads to the FACP Unit. All connections shall be made on terminal strips. All terminal block screws shall have pressure wire connectors of the self-lifting or box lug type. No more than two conductors under one connection. Wire on these terminals shall be labeled. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end with "E-Z markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded. All controls, function switches, etc., shall be clearly labeled on all equipment panels. All wiring shall be checked and tested to ensure that there are no grounds, opens or shorts.

F. All wiring shall be color coded in accordance with the following scheme, which shall be maintained throughout the system, without color change in any wire run. Exception: to this is addressable initiating circuits shall comply with the following Paragraph F.

1.	Initiating Circuits	Yellow(+)/Brown (-)
2.	Alarm Indicating Device Circuits	Red(+)/Blue (-)
3.	AHU Shutdown Circuits	Orange
4.	Door Control Circuits	Gray
5.	Elevator Capture Circuits	Violet

G. Wire shall be 14 AWG minimum, stranded or solid copper, type THHN or THWN except for addressable loop controller circuits. Addressable loop controller circuits are to be wired with type FPL/FPLR/FPLP fire alarm cable, solid copper, AWG 18 minimum, twisted pair, installed in conduit, instead of AWG 14 THHN/THWN stranded conductors. Provide shielded cable if required by manufacturer. If shielded cable is required by manufacturer, cable shield drain wires are to be connected at each device on the loop to maintain continuity and taped to insulate from ground. Terminate the shield at the FACP in accordance with the manufacturer’s instructions. The cable shall have red jacket, with yellow (+) and brown (-) conductors. Cable shall be equal to West Penn 980.

H. All addressable loop controller circuits shall have a minimum of 25% spare addresses for future use. “T” taps from the loop are permitted, but only if they serve no more than 30 initiating devices and/or control points, in an area which does not exceed approximately half of one story. To minimize the impact of a wiring fault on the system, isolation modules must be provided as follows:

1. After each 30 devices/control points on any addressable circuit, including taps.
2. At each “T” tap which feeds 5 or more devices/control points.
3. For each circuit extending outside the building.
4. All isolation modules must be clearly labeled, readily accessible for convenient inspection, and shown on the as-builts.

I. Initiating device or indicating device circuits must not be included in raceways containing AC power or AC control wiring. Within the FACP unit, any AC control wiring must be properly separated from other circuits. The enclosure must have an appropriate warning label to alert service personnel to the hazard.

J. A unique identification number shall be assigned to each detector. (Identification shall be by zone number and device number within the zone.) This number shall be noted on the submittals and as-built plans, and also be permanently mounted adjacent to the detector or affixed to its base.

K. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.
   1. Comply with requirements for seismic-restraint devices specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3.04 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Smoke dampers in air ducts of designated air-conditioning duct systems.
   2. Alarm-initiating connection to activate emergency lighting control.
   3. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
   4. Supervisory connections at valve supervisory switches.
   5. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
   6. Supervisory connections at elevator shunt trip breaker.

B. Control wiring to the air handling shutdown relays shall be supervised from the fire alarm control unit to the relay coil per NFPA 101, Chapter 7-6.5.5. Locate shutdown relay within 3 feet of air handling unit motor starter.

3.05 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.06 POWER CONNECTIONS

A. Provide 120 volt, 20 amp circuit to all fire alarm panels, remote panels, terminal cabinets, etc (whether shown on drawings or not). Connect to spare 20 amp, 1 pole circuit breaker in nearest emergency 120 volt panel. Re-label circuit breaker accordingly. Provide locking device on breaker and color breaker red.

3.07 GROUNDING

A. Ground fire-alarm associated circuits; comply with IEEE 1100.

3.08 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. Visual Inspection: Conduct visual inspection prior to testing.
      a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
      b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
   2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
   3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems"

Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.09 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 263600

TRANSFER SWITCHES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches.

B. Furnish and install automatic transfer switch systems with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer switch shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All automatic transfer switches and controllers shall be the products of the same manufacturer.

C. Furnish an enclosure for the ATS that is for service entry. It shall provide all of the proper disconnecting, protection, grounding and bonding required for service entrance equipment.

D. Upon loss of normal power, transfer switch shall signal generator to start and transfer load to emergency source. 'Life Safety' branch transfer switch shall transfer load to emergency source within 10 seconds upon loss of normal power source.

E. Provide all control wiring from transfer switches to generator for generator start signal and load shed signal. Provide control wiring from transfer switch serving elevators to elevator controller to signal emergency source available.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

   1. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
   2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product include operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Features and operating sequences, both automatic and manual.
   2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain all transfer switches through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 110.

G. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.05 TESTS AND CERTIFICATION

A. The complete ATS system shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

C. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

1.06 WARRANTY

A. Equipment furnished under this specification section shall be guaranteed against defective parts and workmanship under terms of the manufacturer's and dealer's standard warranty. But, in no event, shall it be for a period of less than two years from date of initial start-up of the system and shall include labor and travel time for necessary repairs at the job site.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide ASCO Power Technologies automatic transfer switch or comparable product by one of the following. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included here.
   1. Kohler Power Systems; Generator Division.
   2. Onan/Cummins Power Generation; Industrial Business Group.

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.

B. The transfer switches shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators which include overcurrent disconnect devices, linear motors or gears shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.

C. The switch shall be positively locked and unaffected by momentary outages so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.

D. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand capability and be protected by separate arcing contacts.

E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.

F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.

G. Where neutral conductors must be switched as shown on the plans, the ATS shall be 4-pole with a switched neutral pole. The neutral pole shall be the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar.

H. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.03 MICROPROCESSOR CONTROLLER

A. The controller shall direct the operation of the transfer switch. The controller's sensing and logic shall be controlled by a built-in microprocessor for maximum reliability, minimum maintenance, and inherent serial communications capability. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance.

B. The controller shall be enclosed with a protective cover and be mounted separate from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers.

C. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
   1. ANSI C37.90A/IEEE 472 Voltage Surge Test
   2. NEMA ICS – 109.21 Impulse Withstand Test
   3. IEC801-2 Electrostatic discharge (ESD) immunity
   4. ENV50140 and IEC 801 – 3 Radiated electromagnetic field immunity
   5. IEC 801 – 4 Electrical fast transient (EFT) immunity
   6. ENV50142 Surge transient immunity
   7. ENV50141: Conducted radio-frequency field immunity
   8. EN55011: Group 1, Class A conducted and radiated emissions

9. EN61000 –4 – 11 Voltage dips and interruptions immunity

2.04 ENCLOSURE

A. The automatic transfer switches shall be furnished in a NEMA type 1 enclosure unless otherwise shown on the plans.

B. Controller shall be flush-mounted display with LED indicators for switch position and source acceptability. It shall also include test and time delay bypass switches.

C. For those automatic transfer switches that are less than 1000 amperes, the connection between the normal disconnecting device and the ATS shall be made with the appropriate size cable. For those automatic transfer switches that are greater than 1000 amperes, the connection between the normal disconnecting device and the ATS shall be made with the appropriate size bus. Bus shall be silver plated copper rated no less than 1000 amps per square inch.

D. A pressure disconnect link shall be provided to disconnect the normal source neutral connection from the emergency and load neutral connections for 4-wire applications. A ground bus shall be provided for connection of the grounding conductor to the grounding electrode. A pressure disconnect link for the neutral to ground bonding jumper shall be provided to connect the normal neutral connection to the ground bus.

E. Control wiring shall be rated for 600 volt, UL 1015. Wires shall be placed in wire duct or harnessed and shall be supported to prevent sagging or breakage from weight or vibration. All wiring to hinged doors shall be run through door terminal blocks or connection plugs.

2.05 DISCONNECTING AND OVERCURRENT PROTECTION DEVICE

1. For those automatic transfer switches less than 1000 amperes, the normal connection shall be provided with a thermal magnetic rated molded case circuit breaker with current ratings as shown on the plans. It shall have a thermal magnetic trip unit.
2. For those automatic transfer switches rated above 1000 amperes, the normal connection shall be provided with a stationary mount, insulated case circuit breaker with a solid-state trip unit. The trip unit shall have an adjustable long time, short time, instantaneous, and ground fault trip settings. The insulated case circuit breaker shall trip open when the ground fault setting is exceeded.

2.06 CONTROLLER

A. The following parameters shall only be adjustable via DIP switches on the controller:
   1. Nominal line voltage and frequency
   2. Single or three phase sensing
   3. Operating parameter protection
   4. Transfer operating mode configuration
      a. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.07 VOLTAGE AND FREQUENCY SENSING

A. The voltage of each phase of the normal source shall be monitored, with pickup adjustable to 95% of nominal and dropout adjustable from 70% to 90% of pickup setting.

B. Single-phase voltage and frequency sensing of the emergency source shall be provided.

2.08 TIME DELAYS

A. An adjustable time delay shall be provided to override momentary normal source outages and delay all transfer and engine starting signals.

B. An adjustable time delay shall be provided on transfer to emergency, adjustable from 0 to 5 minutes for controlled timing of transfer of loads to emergency.

C. A generator stabilization time delay shall be provided after transfer to emergency.

D. An adjustable time delay shall be provided on retransfer to normal, adjustable to 30 minutes. Time delay shall be automatically bypassed if emergency source fails and normal source is acceptable.

E. A 5-minute cool down time delay shall be provided on shutdown of engine generator.

F. All adjustable time delays shall be field adjustable without the use of special tools.

2.09 ADDITIONAL FEATURES

A. A set of contacts rated 5 amps, 32 VDC shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.

B. A push-button type test switch shall be provided to simulate a normal source failure.

C. A push-button type switch to bypass the time delay on transfer to emergency, the engine exerciser period on the retransfer to normal time delay whichever delay is active at the time the push-button is activated.

D. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal.

E. Auxiliary contacts rated 10 amps, 250 VAC shall be provided consisting of one contact, closed when the ATS is connected to the normal source and one contact, closed, when the ATS is connected to the emergency source.

F. Indicating lights shall be provided, one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red). Also provide indicating lights for both normal and emergency source availability.

G. Terminals shall be provided to indicate actual availability of the normal and emergency sources, as determined by the voltage sensing pickup and dropout settings for each source.

H. An engine generator exercising timer shall be provided, including a selector switch to select exercise with or without load transfer.

I. An In phase monitor shall be inherently built into the controls. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents and shall not require external control of power sources. The in phase monitor shall be specifically designed for and be the product of the ATS manufacturer.

J. A double throw contact shall be provided to operate after a time delay, adjustable to 20 seconds prior to transfer and reset 0 to 20 seconds after transfer. This contact can be used to selectively disconnect specific load(s) when the transfer switch is transferred. Output contacts shall be rated 6 amps at 28 VDC or 120 VAC.

2.10 OPTIONAL ACCESSORIES

A. Programmable Engine Exerciser: A seven or fourteen day programmable engine exerciser with digital readout display. Shall include one form C contact for availability of normal and emergency sources. Include “with or without” load control switch for exerciser period. The exerciser shall be backed up by a permanent battery. (Accessory 11BG).

2.11 WITHSTAND AND CLOSING RATINGS

A. The ATS shall be rated to close on and withstand the available rms symmetrical short circuit current as shown on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install transfer switch assembly in accordance with manufacturer’s written instructions and NEC.

B. Floor Mounted Switches: Anchor to floor by bolting.
   1. Provide concrete bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support.

3.02 TRANSFER SWITCH STARTUP

A. Retain services of transfer switch manufacturer's factory trained technician to perform following services:
   1. After engine/generator load bank test and after engine/generator set is electrically connected to automatic transfer switches, provide comprehensive demonstration of system maintenance and operation to Owner or Owner's maintenance personnel.
   2. Include minimum of six simulated power failures.

B. Verify operation of remotely connected control wiring and interlocks.

END OF SECTION

SECTION 264313

SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes Surge Protective Devices SPDs for low-voltage (120 to 600 V) power equipment.

1.03 DEFINITIONS

A. SPD: Surge Protective Device(s), both singular and plural.

B. NTRL: Nationally Recognized Testing Lab

C. PER PHASE: Per Phase ratings are determined by multiplying the kA per mode times the number of discrete modes of protection (directly connected mov's), minus the value for the Neutral to ground mode, divided by the number of phases.
   1. Per Phase = (kA per mode minus the N-G mode) X (# of modes) / # of phases.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

1.05 INFORMATIONAL SUBMITTALS

A. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:
   1. UL 1283.
   2. UL 1449 Third Edition listed.

B. Provide submittals for all required testing and pertinent manufacturer information described herein.

C. Surge suppression submittals shall include, but shall not be limited to the following items:
   1. Complete wiring information for ALL SPD units indicating part numbers, conductor sizes, etc.
   2. Submit installation details for all SPD units indicating mechanical and electrical connections to equipment being protected.
   3. Manufacturer shall include their UL 1449 Third Edition and UL 1283 listing number(s).
   4. Documentation from manufacturer stating SPD incorporates all mode protection (i.e. line-to-neutral, line-to-line, line-to-ground, neutral-to-ground) "Reduced-Mode" variations will not be accepted.
   5. Warranty certificate from manufacturer indicating the warranty duration and replacement policy.
   6. Provide a table indicating which panel/switchboard/equipment each SPD unit will serve. Table shall include panel name, voltage/phase, and SPD model number to be provided.

Panel/Switchboard Name	Volts, Phase – 3Wire or 4 Wire	SPD Model Number

D. Test Reports: IEEE C 62.41-2002 Test Reports. Include complete let-through voltage test data (not SVR or VPR), test graphs and scope traces for each and every mode for each product submitted for Category's C, B, A (including Cat A, 2kV, 67A, 100kHz ring wave at both 90 & 270 degree electrical phase angles) This testing shall be conducted exactly as described below.
   1. Let-through Voltage Test Parameters: Positive Polarity, Net voltages are peak (±10%). All tests are static except 150 V MCOV modes. Let-through voltages on static tests calculated by subtracting sinewave peak from let-through measured from zero. 150 V MCOV mode let-through voltages measured from the insertion point on the sinewave. Each phase is the average of the 3 modes. In order to duplicate the results, the specified mode must be tested for all three phases (except N-G) and averaged together. (Individual mode or shot results may vary by more than 10%. Scope Settings: Time Base = 10 microseconds, Sampling Rate = 500 Megasamples/sec. These settings assure Let-through voltages test results are accurate). All tests performed with 6" lead length (external to the enclosure), simulating actual installed performance.

E. Manufacturer Certification: Provide a letter of certification from the manufacturer or factory-authorized service representative certifiying the installation complies with manufacturer's instructions and requirements. Refer to Final Inspection section of this submittal.

F. Substitutions will not be approved. Products submitted must be one of the manufacturers listed and part numbers as listed.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For TVSS devices to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

A. Applicable Documents:
   1. ANSI/IEEE Std C62.41.1™-2002, IEEE Guide on the Surge Environment in Low- Voltage (1000 V and Less) AC Power Circuits
   2. ANSI/IEEE Std C62.41.2™-2002,IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
   3. ANSI/IEEE Std C62.45™ -2002, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits
   4. ANSI C84.1, American National Standard for Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)
   5. IEEE Standard 1100-2005, IEEE Recommended Practice for Power and Grounding Electronic Equipment - Section 8.6.1
   6. UL 1283, Electromagnetic Interference Filters
   7. California Electrical Code (CEC)

B. Qualification Data: Agency Approval/Testing Agency Qualifications - An independent testing 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 definied by OSHA n 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. All SPD devices shall be tested and listed to UL 1449 Third Edition & UL 1283 by a NRTL (CSA, UL, etc)

2. All SPD devices shall comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

C. All SPD devices at the service entrance, distribution panels, branch panels, motor control centers, and individual load applications must be provided by same SPD manufacturer.

D. Manufacturer Qualifications: At least 10 years engineering experience in the design and manufacture of permanently connected SPD devices.
1. Operates a Quality System Certified manufacturing facility as ISO 9001:2000 compliant.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the CEC, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.08 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

1.09 WARRANTY

A. The manufacturer shall provide unlimited free replacement of the entire SPD (not just modules, components or sub-assemblies) for all inoperable SPD during the warranty period. Minimum warranty period shall be 25 (Twenty-Five) years. Acceptable manufactures listed that do not meet the 25 year warranty as standard shall submit a letter extending the warranty with the product submittal.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. The listing of a manufacturer as “acceptable” does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any submittals made are for products that meet or exceed the specifications included herein. Subject to compliance with requirements, provide products by the following manufacturer(s) and listed part numbers, all others will be rejected.

SPD Manufacturer	Service Entrance Type 1, 20kA I_n (Only) (240kA/phase)	Distribution Panelboards 400A & Larger Type 2, 20kA I_n (Only) (180kA/phase)	Branch Panelboards (under 400A) w/ Sine-Wave Tracking Type 2, 20kA I_n (Only) (120kA/phase)
Surge Suppression Incorporated Mike Barton 888.987.8877 www.surgesuppression.com	LSED3Y1ACK-52 (120/208 Volt Wye) LSED3Y2ACK-52 (277/480 Volt, Wye) LSED3N4ACK-52 (480 Volt, Delta) Phy. Size - 8” x 5” x 4” (5lbs.)	SDLB3Y1ACK-52 (120/208 Volt, Wye) SDLB3Y2ACK-52 (277/480 Volt, Wye) SDLB3N4ACK-52 (480 Volt, Delta) Phy. Size - 8” x 5” x 4” (5lbs.)	CKLB3Y1ACKN-52 (120/208 Volt, Wye) CKLB3Y2ACKN-52 (277/480 Volt, Wye) CKLB3N4ACKN-52 (480 Volt, Delta) Phy. Size - 8” x 5” x 4” (5lbs.)

2.02 GENERAL REQUIREMENTS

A. Surge Protection Devices Minimum Requirements:
   1. ANSI/UL 1449-2006 (aka UL 3RD Edition) Listed by UL to satisfy UL961 requirements.
   2. LED indicator lights for power and protection status.
   3. Battery powered Audible alarm, with silencing switch, to indicate when protection has failed.
   4. Form-C dry relay contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device.
   5. Permanently-connected, parallel mounted.
   6. Solid-state clamping components to limit the surge voltage and divert the surge current. SPD components that “crowbar” (e.g. spark gaps, gas tubes, SCR’s, etc.) not allowed.
   7. Capable of sustaining 115% of nominal RMS voltage continuously without degrading.
   8. The SPD device shall be tested and listed by a NRTL as a complete assembly to a symmetrical fault current rating greater than or equal to the rating of the connected panel, in accordance with the CEC and shall be marked with the short circuit current rating.

B. Modes of Protection:
   1. SPD units shall provide Line to Line, Line to Neutral, Line to Ground, and Neutral to Ground protection. Reduced mode devices are not acceptable.

C. Fusing
   1. Provide as a minimum, over-current, over temperature protection in the form of component-level thermal fusing to ensure safe failure and prevent thermal runaway. This component-level fusing shall be an integral part of the MOV itself, and not silver wire (or other) independently layed across each MOV.
   2. Provide integral short circuit current fusing within each device. This fusing will be independent of the “component-level” fusing and specifically for over-current protection and shall be constructed utilizing surge rated, cartridge fuses and not rated ‘silver-fuse-wire’ (or other).
   3. The fusing mechanisms employed must effectively coordinate their performance in conjunction with the high current abnormal over-voltage testing under UL 1449 Third Edition.
   4. The use of any mechanical or electro-mechanical thermal/over-current protection (i.e. moving parts and/or springs and shutters), in combination with or for the protection of the suppression elements are expressly prohibited and will be rejected.
   5. Large-Block 34mm (50kA) square Thermal Protected MOVs are expressly prohibited and will not be accepted

D. Maintenance Restrictions
   1. No suppression unit shall be supplied which requires scheduled preventive- maintenance or replacement parts. Units requiring functional testing, special test equipment, or special training to monitor surge protection device (SPD) status are not acceptable. SPD devices shall require no routine maintenance. SPD devices are considered non-repairable items and shall be fully replaced upon failure.

E. Enclosures
   1. Unless otherwise noted, NEMA 1 (or better) enclosures for indoor installations and NEMA 4X or better enclosures for outdoor/wet locations shall be utilized.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide surge suppression at each building service entrance switchboard or panelboard, and at other locations as indicated on the Contract Drawings.

B. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

C. Install devices for panelboard 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.
   1. Provide multipole, 30 amp circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

3.02 FIELD QUALITY CONTROL

A. Electrical Service, Distribution Panels, Branch Panelboards, and Motor Control Centers:
   1. Provide surge suppressor at each building service entrance and at other panelboard and motor control center locations as indicated on the drawings. The SPD shall be located immediately adjacent to the switchboard or panelboard being protected (close-nipple to panelboards). The SPD may not be located integral within the switchboard or panelboard(s) unless specifically noted on drawings. SPD devices not meeting or exceeding the performance of this specification will be deemed unacceptable.
   2. Install the SPD with #10 AWG minimum conductors to a 30-amp breaker in panel per manufacturer’s installation instructions. The phase and neutral conductors serving the SPD shall be twisted together (one twist per 12” of lead length) to reduce the SPD system input impedance and kept at the minimum length. The SPD shall be installed in strict accordance with the manufacturer’s recommended practices and in compliance with CEC requirements. If the SPD manufacturer requires larger size conductors and breaker, Contractor shall provide conductors and breaker size per manufacturer’s requirements. No. 10 conductors and 30 amp breaker size are based on Surge Suppression Inc. requirements. If Contractor chooses to use an alternate manufacturer, Contractor shall provide conductors and breaker size per manufacturer’s requirements at no additional cost.
   3. If lead lengths exceed 18” the Contractor responsible for installation must contact the surge suppression manufacturer for installation assistance.

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. The surge protection installation shall be certified by a licensed electrician that the installation is in accordance with the manufacturer’s recommendations, CEC requirements and the requirements of the specification above. Any deficiencies noted shall be corrected by the Contractor. Provide written documentation of this inspection as part of the closeout documents/manual.

E. The surge suppression installation must be inspected and certified by a factory-trained representative of the SPD manufacturer. In completing this start-up, the factory-trained inspector shall furnish the Engineer with a letter/report stating that all devices are the correct specified model numbers, in the correct locations and designations, and installed in strict accordance with the intent of this specification and the requirements of the manufacturer. The Contractor must make the manufacturer aware of the available dates to perform this inspection and must give at least 45 days notice of the required deadline date. The cost for this service must be included in the package price of the SPD device and is to be part of the construction bid package. The inspection will include one on-site visit and inspection accompanied by the report as stated

above. Subsequent visits to correct problems created by the installer and not in accordance with the intent of the requirements of this specification and the installation instructions furnished by the manufacturer as noted in the report will be the ultimate responsibility of the Contractor and will be billed on a time and travel reimbursable basis until the Engineer receives final satisfactory certification from the manufacturer of the specified system.

3.03 STARTUP

A. Do not energize or connect service entrance equipment, panelboards and other electrical equipment 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.

END OF SECTION

SECTION 265100

INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Interior luminaires, lamps, and ballasts.
   2. Emergency lighting units.
   3. Exit signs.

B. Related Sections include the following:
   1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, and multipole lighting relays and contactors.
   2. Division 26 Section "Wiring Devices" for manual wall-box dimmers.

1.03 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. CU: Coefficient of utilization.

D. LED: Light Emitting Diode.

E. LER: Luminaire efficacy rating.

F. Luminaire: Complete luminaire, including ballast housing if provided.

1.04 ACTION SUBMITTALS

A. Contractor shall provide submittals for luminaires as indicated in the “Lighting Fixture Schedule.” Where an alternate manufacturer is indicated for a specific luminaire with no catalog number indicated for the alternate manufacturer, provide alternate luminaire that is equal in all characteristics as the cataloged luminaire. Luminaires without alternate manufacturers noted shall be provided with no substitutions and/or alternates.

B. Excess delivery times shall not be an acceptable cause for substitution of specified luminaires. Notify Architect/Engineer of any long lead luminaires that may impact project schedule within two weeks of contract award. Beyond two weeks the contractor is responsible for any costs associated with expediting the manufacturing process of the specified luminaire and/or cost associated with an approved substitute luminaire is allowed by Architect/Engineer.

C. Product Data: For each type of luminaire submit catalog literature for each luminaire specified in booklet form with index and a separate sheet for each luminaire, assembled in luminaire “type” alphabetical order, with specified luminaire data as required below.

D. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Energy-efficiency data.
   4. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
   5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each luminaire type. The

adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.

a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

6. LED compliance testing documentation in accordance with IESNA LM-80 and the DOE CALiPER testing documentation for all solid state luminaires.

E. Shop Drawings: For nonstandard or custom luminaires. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

F. Installation instructions.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified agencies providing photometric data for luminaires.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and luminaires to include in emergency, operation, and maintenance manuals.
   1. Provide a list of all lamp types (if applicable) used on Project; use ANSI and manufacturers' codes.

1.07 QUALITY ASSURANCE

A. Equivalency of luminaires is determined by Engineer and includes the following data for comparative purposes.
   1. Efficiency.
   2. Efficacy.
   3. Distribution.
   4. Construction.
   5. Design compatibility.
   6. Manufacturer reliability based upon past performances.

B. 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.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the California Electrical Code (CEC), by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

D. Comply with NFPA 70.

1.08 COORDINATION

A. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.09 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: 1 for every 10 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: 1 for every 25 of each type and rating installed. Furnish at least one of each type.
3. Battery and Charger Data: 1 for each emergency lighting unit.
4. Transformers/LED Drivers: 1 for every 25 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

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings where only one manufacturer is listed, provide one of the products indicated on Drawings where multiple manufacturers are listed.

2.02 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS

A. Provide luminaires of the size, type and rating indicated in “Lighting Fixture Schedule”, complete with, but not necessarily limited to, lamps, lampholders, reflectors, ballasts, drivers, starters, wiring and any other accessories required for a complete working installation.

B. Luminaire catalog numbers do not necessarily include all accessories and are intended to serve as a guide in defining types and manufacturers of luminaire only.

C. The contractor shall ensure that the luminaire is UL/ETL listed for the ambient conditions where installed. Extra compensation will not be permitted for failure to coordinate luminaires with their ambient conditions.
   1. Luminaires located exterior to the building and/or in unconditioned damp spaces and under cover from direct weather exposure shall be UL/ETL listed as “Suitable for Damp Locations” unless noted otherwise.
   2. Luminaires located exterior to the building and/or in unconditioned wet spaces and in direct contact with the weather or in washdown areas shall be UL/ETL listed as “Suitable for Wet Locations” unless noted otherwise.

D. Luminaires installed with direct contact with insulation shall have an “IC” rating for direct contact with insulation. Verify if luminaires will be in contact with insulation prior to installation. Notify Architect/Engineer of any conflicts.

E. Gasketing material shall be vinyl or other non-aging type material as approved by Engineer.

F. Provide proper trim for each luminaire as required for various types of ceiling being installed throughout the project; plaster rings, luminaire ends or caps, suspension units, mounting brackets and/or other accessory parts necessary for a complete luminaire.

G. Recessed Luminaires: Comply with NEMA LE 4 for ceiling compatibility for recessed luminaires.

H. Metal Parts: Free of burrs and sharp corners and edges.

I. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

J. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

K. Diffusers, Covers, and Globes:
   1. Acrylic Luminaire Diffusers: Plastic for clear lenses and diffusers shall be formed of colorless 100% virgin acrylic, as manufactured by Atohaas, DuPont or equally acceptable

manufacturer. The quality of the raw material must meet or exceed IES, SPI, and NEMA Specifications and shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent testing laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 10 years.

a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
b. UV stabilized.

2. Glass: Glass used for lenses, refractors, and diffusers in incandescent luminaires shall be tempered for high impact and heat resistance; where clear glass has been specified, the glass shall be crystal clear in quality with a transmittance of not less than 88%. Where luminaire glass lenses are specified glass lenses shall be provided and plastic lenses shall not be substituted.
3. Provide clear tube guards over exposed fluorescent lamps in all strip and industrial luminaires in unfinished spaces. Equal to ALP Protect-A-Lamp.

L. Factory-Applied Labels: Comply with UL 1598.
1. All light fixtures shall factory-applied label near lamp socket stating maximum wattage of lamp allowed in fixture. Maximum wattage to be stated is wattage as shown on schedule of lighting equipment herein. Circuits are based on these wattages, circuitry, etc. Any failure to comply with this requirement shall be responsibility of contractor. Location of labels must meet acceptance of lighting designer, architect and engineer.
2. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

2.03 LED LUMINAIRES

A. LED luminaires shall provide a continuous and controllable light source. Lamp output and dimensions shall be in accordance with contract drawings and specifications. LED luminaire lumen output will be in accordance with the specifications and shall not depreciate more than 20% after 10,000 hours of use. Rated lumen output for LED luminaires to operate in ambient temperature of minus 4°F -20°C to 122°F +50°C. Luminaires to have minimum life of 50,000 hours.

B. All LEDs used in the LED luminaires will be of high brightness and proven quality. All LEDs shall be driven digitally with pulse width modulation control to prolong life and maintain consistency of lumen output.

C. All connections to luminaires will be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

D. Fuse Protections: All power supply outputs will be either fuse protected or PTC-protected as per Class 2 UL listing. All luminaires will have built-in fuse protection. All power supplies will provide for knockouts for conduit connections or clamp-style connection for the low-voltage wiring.

2.04 LED DRIVERS (POWER SUPPLIES)

A. All LED drivers to be compatible with LEDs. All LED luminaires and drivers (power supplies) shall be furnished by single manufacture to insure compatibility.

B. Electric Characteristics (at 77°F ambient temperature)
1. Input Voltage Range - 108V to 132V
2. Efficiency Minimum – 80%
3. Output Current Regulation Range (+/-) 5%A
4. Total Harmonic Distortion (THD) – 20% maximum
5. Power Factor – 0.9 minimum
6. Crest Factor (LED Current) – 1.5 maximum
7. FCC Class B for Conducted EMI

8. FCC Class A for Radiated EMI
9. Drivers life – 50,000 hours minimum

2.05 LUMINAIRE 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.

B. Suspended luminaires shall have swivel type aligner hangers in ceiling boxes to ensure plumb suspension.

C. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire. Where stems are furnished by luminaire manufacturer, verify length prior to releasing shipment.

D. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single luminaire. Finish same as luminaire. Where stems are furnished by luminaire manufacturer, verify length prior to releasing shipment.

E. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage, minimum.

F. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage, minimum.

G. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

H. Hook Hangers: Integrated assembly matched to luminaire and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Architect's and/or Interior Designer's reflected ceiling plans indicate actual location of all luminaires. Notify Architect/Engineer of any conflicts between these plans and electrical documents prior to rough-in and installation.

B. Architect's and/or Interior Designer's elevation and/or section plans may show actual location of luminaires that are not documented on the reflected ceiling plans. If luminaires are not shown on elevation and/or section plans, install at height noted on the electrical documents. Notify Architect/Engineer of and conflicts between these plans and electrical documents prior to rough-in and installation.

C. Temporary Lighting: If it is necessary, and approved by the Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps and reinstall.

D. Remote Mounting of Transformers/ LED Drivers: Distance between the power supply and luminaire shall not exceed that recommended by equipment manufacturer. Verify, with the manufacturers, maximum distance between ballast and luminaire.

E. Verify adequacy of headroom and non-interference with other equipment such as ducts, pipes and openings. Report to Architect/Engineer any conflict between these plans and electrical documents.

F. Install luminaires in mechanical and unfinished areas after ductwork and piping installation. Adjust luminaire locations to provide the best lighting for equipment access and service locations. Locate luminaires 8'-6" above floor or at suitable locations within space or on walls but not lower than 7'-0" .

G. Adjustable luminaires shall be aimed as directed by Architect/Interior Designer/Engineer.

H. Special care shall be taken to assure light-tight joints between recessed luminaires and ceiling systems.

I. Recessed luminaires which are installed in rough textured ceiling surfaces whereby light may be emitted between luminaire frame and ceiling surface shall have black self-adhesive polyfoam gasketing installed around inside edges of frame to prevent light leaks.

J. Install luminaires in a workmanlike manner. Care shall be taken in placement of luminaire outlets and surface-mounted luminaires to maintain alignment, spacing, layout, and general arrangement shown on drawings. Contractor may vary these dimensions slightly in order to clear obstructions. Any major changes in the arrangement must be approved by Engineer.

K. Luminaires: Set level, plumb, and square with ceilings and walls. Install lamps in each luminaire.

L. Air-Handling Luminaires: Install with dampers closed and ready for adjustment.

M. Coordinate with trades so luminaires are properly aligned with items such as diffusers, grilles, and speakers

N. If necessary, relocate luminaires as directed by Lighting Designer so there will be no conflict with other equipment.

O. Make luminaire holes for wire entrance with knock-out punches or hole saw, remove burrs. Do not cut holes with tinsnips.

P. In areas where there is exposed food, clean equipment, utensils, linens or unwrapped single-service and single use articles, lamps shall be shielded, coated or otherwise shatter-resistant.

Q. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

R. Clean luminaires of dirt and debris prior to acceptance.

S. Maintain clearance as required in the CEC and other NFPA sections. Notify Lighting Designer of any conflict, prior to rough-in.

T. Comply with all relevant Federal, State, Local and Agency guidelines when disposing of lighting waste. Most fluorescent and HID lamps require special handling and disposal procedures.

U. Electrical contractor shall remotely locate all transformers called for in the contract documents in a well ventilated and easily accessible space to comply with all codes.

3.02 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL

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.

B. At time of Substantial Completion, replace lamps in luminaires which are observed to be noticeably dimmed after Contractor's use and testing, as judged by Lighting Designer.

END OF SECTION

SECTION 265600

EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Exterior luminaires.

1.02 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. LER: Luminaire efficacy rating.

D. Luminaire: Complete lighting fixture, including ballast housing if provided.

E. Pole: Luminaire support structure, including tower used for large area illumination.

1.03 SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.04 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Ice Load: Load of 3 lbf/sq. ft. (145 Pa), applied as stated in AASHTO LTS-4-M Ice Load Map.

C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.
   1. Basic wind speed for calculating wind load for poles 50 feet (15 m) high or less is 100 mph (45 m/s).
      a. Wind Importance Factor: 1.0.
      b. Minimum Design Life: 25 years.
      c. Velocity Conversion Factors: 1.0.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. ANSI/NFPA 70, National Electrical Code.

D. IEEE C62.41, Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.

E. FCC 47 CFR Part 15, Federal Code Of Regulation (CFR) testing standard for electronic equipment.

F. IESNA LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products.

G. IESNA LM-80, Approved Method for Measuring Lumen Maintenance of LED Light Sources.

H. IESNA TM-15, Luminaire Classification System for Outdoor Luminaires.

I. UL1598, Standard for Safety of Luminaires.

J. NEMA SSL 3-2010, High-Power White LED Binning for General Illumination.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
   1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
   2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
   3. Warranty Period for Color Retention: Five years from date of Substantial Completion.

B. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products from one of the manufacturers listed in fixture schedule.

2.02 LED LUMINAIRES

A. General: Except as otherwise indicated, provide LED luminaires with characteristics indicated on the fixture schedules.

B. Material and specifications for each luminaire are as follows:
   1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply).
   2. Each luminaire shall be rated for a minimum operational life of 50,000 hours at an average operating time of 11.5 hours per night. This life rating must be conducted 40C ambient temperature.
   3. The rated operating temperature range shall be -30°C to +40°C.
   4. Each luminaire is capable of operating above 100°F, but not expected to comply with photometric requirements at elevated temperatures.
   5. Photometry must be compliant with IESNA LM-79 and shall be conducted at 25°C ambient temperature.
   6. The individual LEDs shall be constructed such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
   7. Luminare shall be constructed such that LED modules may be replaced or repaired without replacement of whole luminaire.
   8. Each luminaire shall be listed with Underwriters Laboratory, Inc. under UL1598 for luminaires, or an equivalent standard from a nationally recognized testing laboratory.

C. Technical Requirements
   1. Electrical
      a. Power Consumption: Maximum power consumption allowed for the luminaire shall be determined by application. The luminaire shall not consume power in the off state.
      b. Operation Voltage: The luminaire shall operate from a 60 HZ ±3 HZ AC line over a voltage ranging from 108 VAC to 305 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output.
      c. Power Factor: The luminaire shall have a power factor of 0.90 or greater.

d. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 10 percent.
e. Surge Suppression: The luminaire on-board circuitry shall include fused surge protection devices (SPD) to withstand high repetition noise transients as a result of utility line switching, nearby lightning strikes, and other interference. The SPD shall protect the luminaire from damage and failure for common mode transient peak voltages up to 10 kV (minimum) and transient peak currents up to 5 kA (minimum). SPD shall conform to UL 1449 depending of the components used in the design. SPD performance shall be tested per the procedures in ANSI/IEEE C62.41-1992 (or current edition) for category C (standard). The SPD shall fail in such a way as the Luminaire will no longer operate. The SPD shall be field replaceable.
f. Each Luminaire shall have integral UL Listed Class II power supplies. Class I power supplies will not be acceptable.
g. Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.
h. RF Interference: LED Drivers must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 regulations concerning the emission of electronic noise.
i. Drivers shall have a Class A sound rating.

2. Photometric Requirements
   a. Optical Assemblies: LEDs shall be provided with discreet over optical elements to provide IESNA Type II, III, IV or V distributions. Additional distributions for spill light control shall be utilized when light trespass must be mitigated. Mitigation must take place without external shielding elements. Optical assemblies shall have a minimum efficiency of 85% regardless of distribution type. For Type II and Type III distributions street side efficiencies shall be a minimum of 80%. All LEDs and optical assemblies shall be mounted parallel to the ground. All LEDs shall provide the same optical pattern such that catastrophic failures of individual LEDs will not constitute a loss in the distribution pattern.
   b. Illuminance: The illuminance shall not decrease by more than 30% over the expected operating life. The measurements shall be calibrated to standard photopic calibrations.
   c. Light Color/Quality: The luminaire shall have a correlated color temperature (CCT) range of 4,000K to 4,500K. The color rendition index (CRI) shall be 70 or greater. Binning of LEDs shall conform to ANSI/NEMA SSL 3-2010.
   d. Backlight-Uplight-Glare: The luminaire shall not allow more than 10 percent of the rated lumens to project above 80 degrees from vertical. The luminaire shall not allow more than 2.5 percent of the rated lumens to project above 90 degrees from vertical. Backlight and Glare ratings as per fixture schedule and calculated per IESNA TM-15.
3. Thermal Management
   a. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.
   b. The LED manufacturer’s maximum thermal pad temperature for the expected life shall not be exceeded.
   c. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.
   d. The luminaire shall have a minimum heat sink surface such that LED manufacturer’s maximum junction temperature is not exceeded at maximum rated ambient temperature.
   e. The heat sink material shall be aluminum.
4. Physical and Mechanical Requirements
   a. The luminaire shall be a single, self-contained device, not requiring on-site assembly for installation. The power supply for the luminaire shall be integral to the unit.
   b. The assembly and manufacturing process for the LED luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration from high winds and other sources.

c. Luminaires shall be capable of withstanding cyclical loading in (G = Acceleration of Gravity): a minimum peak acceleration level of 3.0 G peak-to-peak sinusoidal loading with the internal driver installed, for a minimum of 100,000 cycles without failure of any luminaire parts. Testing to be performed in three planes: a horizontal plane parallel to the direction of mounting, a horizontal plane perpendicular to the direction of mounting and the vertical plane.
d. The housing shall be designed to prevent the buildup of water on the top of the housing. Exposed heat sink fins shall be oriented so that water can freely run off the luminaire and carry dust and other accumulated debris away from the unit.
e. The optical assembly of the luminaire shall be protected against dust and moisture intrusion per the requirements of IP-66 (minimum) to protect all optical components.
f. The electronics/power supply enclosure shall meet the requirements for NEMA/UL wet location.
g. Each mounted luminaire may be furnished without a photoelectric unit receptacle as per fixture schedule.
h. Door shall be hinged and secured to the housing in a manner to prevent its accidental opening.
i. The circuit board and power supply shall be contained inside the luminaire. Electrolytic capacitors used in the power supplies shall be rated for -40°F to 220°F (-40°C to +105°C), long life (> 5000 hours), and operated at no more than 70% of their rated voltage, and 70% of rated current.

5. Materials
   a. Housings shall be fabricated from materials that are designed to withstand a 3000-hour salt spray test as specified in ASTM Designation: B117.
   b. Each refractor or lens shall be made from UV inhibited high impact plastic such as acrylic and be resistant to scratching.
   c. Polymeric materials (if used) of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VO flame retardant materials. The len(s) of the luminaire are excluded from this requirement

2.03 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.
   1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
   2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
   1. Materials: Shall not cause galvanic action at contact points.
   2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
   3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork as specified on drawings.

2.04 STEEL AND/OR ALUMINUM POLES

A. Refer to Drawings.

PART 3 - EXECUTION

3.01 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.
   1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

3.02 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
   1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
   2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.
   1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
   2. Install base covers unless otherwise indicated.

E. Raise and set poles using web fabric slings (not chain or cable).

3.03 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap rigid metal conduit (if used) with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.04 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.05 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
   1. Verify operation of photoelectric controls.
   2. 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

END OF SECTION

SECTION 270500

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, Division 00 and Division 01 Specification Sections, apply to this Section.

1.02 RELATED WORK AND REQUIREMENTS

A. Section 233005 – Coordination Drawings

B. Section 270526 – Grounding and Bonding for Communications Systems

C. Section 270528 – Pathways for Communications Systems

D. Section 271100 – Communications Equipment Room Fittings

E. Section 271300 – Communications Backbone Cabling

F. Section 271500 – Communications Horizontal Cabling

G. Section 281300 – Electronic Access Control

1.03 WORK INCLUDED IN THE LOW VOLTAGE COMMUNICATIONS CONTRACT

A. The mention of an Article, operation or method requires that the Low Voltage Contractor shall provide same and perform each operation in accordance with the conditions stated. The Low Voltage Contractor shall provide material, labor, equipment and transportation to complete the project in compliance with the Contract Documents to provide a complete and fully functional installed system.

B. Work shall be installed in accordance with State and Local Inspection Authorities having jurisdiction together with the recommendations of the manufacturer whose equipment is to be supplied and installed under this Contract.

C. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

D. It is the intent that these Specifications and Drawings are to establish minimum requirements for methods, products and equipment and to provide electrical service, distribution and systems finished, tested and ready for operation. Incidental detail not usually shown or specified, but necessary for proper installation and operation shall be included in the work and the Low Voltage Contractor's estimate, the same as if specified. Locations of all equipment and material shall be adjusted at no extra cost to the Owner, to accommodate the work interferences anticipated and/or encountered. Prior to installation, determine the exact route and location of each raceway and piece of equipment to minimize conflicts with other trades. The Low Voltage Contractor, in conjunction with the Architect, Engineer, and Owner's representative, shall establish exact locations of materials and equipment to be installed. Consideration shall be given to construction features, equipment of other trades and requirements of the equipment proper.

E. Give notices, file plans, obtain permits and licenses, pay fees and back charges, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

F. Before submitting a bid, each bidder shall examine the drawings relating to their work and shall become informed as to the extent and character of the work required and its relation to other work in the building.

G. This project will be phased, as defined by the Owner and Architect. This will necessitate the provision of temporary cabling and connectivity to maintain newly constructed and existing areas of the project that may be affected by the phasing of construction. The Low Voltage contractor shall be responsible for providing, installing and removing all temporary cabling and connectivity as required in their original bid. All associated appurtenances with the utilities shall be provided as part of this project.

H. Materials shall be suitably stored and protected prior to installation and work shall be protected after installation, during construction and prior to acceptance.

I. The Low Voltage Contractor shall furnish scaffolding, rigging, hoisting and services necessary for delivery, erection and installation of equipment and apparatus required to be installed by the Low Voltage Contractor. This equipment shall be removed by the Low Voltage Contractor upon completion of the project.

1.04 DEFINITIONS

A. The Owner/Project Manager. The individual who the Owner selects as the project representative.

B. The Architect shall act at the “Prime Design Consultant”: PGAV

C. The Engineer. exp U.S. Services Inc. Orlando, Florida

D. The General Contractor. The contractor responsible for the construction of the project, general trades and building system subcontracting (HVAC, Electrical, Plumbing, Fire Protection, etc.)

E. The Low Voltage Contractor. The low voltage communications systems contractor.

F. Provide. Used within these sections “provide” shall mean “furnish and install.” “Furnish” shall mean “to purchase and deliver to the project site complete with every necessary appurtenance and support,” and “install” shall mean “to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.”

G. 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.

H. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

I. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

J. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

K. 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.

L. Code. National, State and Local Electrical codes including OSHA requirements.

M. Substitution. Manufacturer or method other than those listed by name in these specifications, on the drawings, or in an addendum.

N. Signal voltage. NEC class 1, 2, or 3 remote control, signaling, or power limited circuits.

O. Electrical ductbank. Assembly consisting of electrical conduits encased in concrete.

1.05 ABBREVIATIONS

A. A/E: Architect or Engineer

B. ANSI: American National Standards Institute

C. ASTM: American Society for Testing Materials

D. BICSI: Building Industry Consulting Services International

E. EIA: Electronic Industries Alliance

F. ENGR: Engineer

G. IEEE: Institute of Electrical and Electronic Engineers

H. NEC: National Electrical Code

I. NEMA: National Electrical Manufacturer's Association

J. NFPA: National Fire Protection Association

K. OSHA: Occupational Safety and Health Administration

L. TIA: Telecommunications Industry Association

M. UL: Underwriter's Laboratories

1.06 PERMITS AND LICENSES

A. The Low Voltage Contractor shall prepare and submit applications and working drawings to authorities having jurisdiction over the project. Licenses and permits required shall be secured and paid for by the Low Voltage Contractor.

1.07 STANDARDS AND CODES

A. Work shall be installed in accordance with National, State, and Local codes, ordinances, laws, and regulations. Comply with applicable OSHA regulations.

B. Work shall be installed in accordance with BICSI, IEEE, ANSI, and TIA/EIA standards.

C. Materials shall have a UL or ETL label where a UL or ETL Standard or test exists.

1.08 DIMENSIONS AND DEFINITE LOCATIONS

A. The drawings depicting communications systems work are diagrammatic and show, in their approximate location, symbols representing electrical equipment and devices. The exact location of equipment and devices shall be established in the field in accordance with instructions from the Architect as established by manufacturer's installation drawings and details.

B. The Low Voltage Contractor shall refer to shop drawings and submittal drawings for equipment requiring communications connections to verify rough-in and connection locations.

C. Unless specifically stated to the contrary, no measurement of a communications drawing derived by scaling shall be used as a dimension to work by. Dimensions noted on the communications drawings are subject to measurements of adjacent and previously completed work. Measurements shall be performed prior to the actual installation of equipment.

D. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

1.09 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of installation and removal of the equipment with minimum interference to other installations or equipment.

B. 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."

1.10 CONTRACT DOCUMENTS

A. Listing of Drawings does not limit responsibility of determining full extent of work required by these Contract Documents. Refer to Architectural, HVAC, Plumbing, Fire Protection, Electrical, Structural, Site Utility and all other Drawings and other Sections that indicate types of construction in which work shall be installed and work of other trades with which work of Division 26, 27 and 28 must be coordinated.

B. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

C. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

D. Information and components shown on riser diagrams but not shown on plans, and vice versa, shall apply or be provided as if expressly required on both.

E. Data that may be furnished electronically by the Architect (on computer tape, diskette, or otherwise) is diagrammatic. Such electronically furnished information is subject to the same limitation of precision as heretofore described. If furnished, such data is for convenience and generalized reference, and shall not substitute for Architect's sealed or stamped construction documents.

1.11 ELECTRONIC MEDIA

A. Electronic media of **exp**'s Contract Documents may be requested by the Low Voltage Contractor. Requests should be made by filling out the following form and providing an authorized signature. These files will be provided on CD in Revit format. If any other media or Revit version is requested, then additional fee may be required. **exp** will not release the information requested prior to receipt of both the completed Release of Liability form and a check for the appropriate documents.

Exp U.S. Services Inc.
ELECTRONIC MEDIA DOCUMENTS
PROPERTY RIGHTS AND LIMITATION OF LIABILITY

_____
_____ (replace with appropriate Corporation name) acknowledges and appreciates that as a favor, without compensation beyond the cost of processing the request, to _____, **exp**, Inc., (hereinafter **exp**) will provide to us certain electronic media files for use on the above referenced project for our own preparation of shop and/or coordination drawings. We assume all responsibility to determine if this information is applicable and/or accurate for intended use.

_____ agrees to accept the electronic media files from **exp** without any warranties, guarantees or other representation of any nature concerning the accuracy or completeness of any information described or depicted therein with respect to any dimensions, measurements, fit, field construction conditions, or criteria. _____ further agrees to release, indemnify and hold harmless **exp** with respect to any claims, cost and/or liabilities between **exp** and ourselves and/or a third party to whom we release information, arising out of or relating to the accuracy and/or completeness of this information.

All materials in the nature of electronic media files are instruments of **exp** for use solely with respect to this Project and **exp** shall be deemed the author of these documents and shall retain all common law and statutory and other reserved rights including copyright thereto.

Notwithstanding the foregoing, such copies of electronic media documents shall not be used by the Contractor on other projects, for additions to this Project or for completion of this Project by others.

I certify that I am an officer of _____ and authorized by same to provide and agree to the above terms and conditions.

For _____

_____
Signature

_____
Print Name

_____
Title

_____
Date

Drawing List Requested

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1.12 DRAWINGS / RECORD DOCUMENTS

A. The Low Voltage Contractor shall keep a detailed up-to-date record, of the manner and location in which installations are actually made, indexing each feeder, pull box and protective device. Upon completion of the project, the contractor shall modify the project electronic drawing and specification files to incorporate this information. Modified documents shall be turned over to the Owner and Engineer in both electronic and hard paper copy formats. Record drawings shall also include:
   1. Locations of buried conduit or similar items. Include buried depth.
   2. Field changes of dimension or detail.
   3. Changes made by field order or change order.
   4. Details not on original contract drawings.

B. As Built Drawings – Refer to the individual Division 26, 27 and 28 Specification Section for As-Built Drawing requirements.

C. In the event of a conflict between the drawings and specifications, this Contractor shall base their bid on the greater quantity, cost or quality of the item in question, unless conflict is resolved by an addendum.

D. Take photographs of all concealed equipment in gypsum board ceilings, shafts, underground (buried) piping routes and supports and other concealed, inaccessible work. At completion of work, make copies of photographs with written explanation for each photo. These shall become part of Record Documents.

E. Underground and utility work shall be located by distances to landmarks, such as building foundations. Give actual dimensions of everything installed including elevations and elevations at each change in direction.

F. Drawings shall also show record condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall incorporate actual manufacturer and make and model numbers of final equipment installation.

G. The Engineer/Architect will not certify the accuracy of the record drawings - this is the sole responsibility of the Contractor.

H. When required by the jurisdiction, each trade shall submit the record set for approval by the building department in a form acceptable to the department. Any document format size changes, and supplemental information required for the submittal are the responsibility of the contractor.

I. Quality of Record Documents shall equal or exceed that of original Contract Documents.

J. The record documents shall be submitted in electronic media format to the Architect/Engineer for review and approval, prior to Application for Final Payment.

1.13 DISCREPANCIES IN DOCUMENTS

A. Where Drawings or Specifications conflict or are ambiguous, advise the Architect in writing before Award of Contract. Otherwise, the Architect/Engineer's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or ambiguities thus resolved.

B. Where Drawings or Specifications do not coincide with manufacturers' recommendations, or with applicable codes and standards, alert the Architect in writing before installation. Otherwise, make changes in installed work as the Architect requires within Contract Price.

C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specifications, this contractor shall provide that material, installation, or work which is of the higher, more stringent standard.

D. It is the requirement of these Contract Documents to have the contractor provide systems and components that are fully complete, operational and suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements. In cases such as this, where the Low Voltage Contractor has failed to notify the Architect of the situation in accordance with Paragraph (A) above, the Low Voltage Contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

1.14 REQUESTS FOR INFORMATION (RFI'S)

A. If the RFI is a request to resolve a conflict or an ambiguity, or a request for additional detail, the Low Voltage Contractor's RFI shall include a sketch or equivalent description of Low Voltage Contractor's proposed solution.

B. To expedite the flow of RFI's, for all RFI's under Divisions 27 and 28, the Low Voltage Contractor shall submit the attached form, or similar form including the same information, to the Architect. Contractor shall include proposed solution in the indicated space on the form.

1.15 SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of Division 26, 27 and 28. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

B. The Low Voltage Contractor shall visit job site to familiarize himself with the specific location of the new equipment installations in existing areas, to ensure there is adequate access for the installation of equipment. All entries, pathways, corridors, stairwells, etc., that may be used to install equipment shall be investigated. All existing conditions and potential obstructions that may impede access and installation shall be addressed prior to equipment purchasing/ordering.

1.16 EXISTING CONDITIONS AND PREPARATORY WORK

A. Before starting work in a particular area of the project, visit site and examine conditions under which work must be performed including preparatory work done under other Divisions/ Sections or other Contracts or by the Owner. Report conditions that might affect work adversely, in writing, through the General Contractor to the Architect via RFI. Do not proceed with work until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.

B. The documentation of existing conditions was derived from As-Built documents and is in part unverified. Actual existing conditions shall be verified prior to commencement of work.

1.17 TEMPORARY/ CONTINUITY OF UTILITY SERVICES

A. Refer to Division 1 - General Requirements, regarding specific requirements.

B. Provide temporary services where project construction schedule requires extended shut downs of existing equipment and/or systems. Temporary services include the necessary equipment and/or systems to maintain continuity of services. Extended shut downs are interruptions of existing services for a period of time longer than that acceptable to the Owner.

C. Do not interrupt existing services from either the owners voice and data networks or the utility service providers voice and data networks without written Owner's approval.

D. Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.

E. Interruptions shall be scheduled at such times of day and work so that they have minimal impact on Owner's operations.

F. Contractor shall coordinate any shutdowns of existing systems as follows:
   1. Give proper notice to Owner when making shutdowns; a minimum of 14 full days is required.
   2. Minimize timeline of shutdowns of any system.
   3. Provide temporary services where required and perform shutdowns and tie in's at a time convenient to Owner.
   4. Contractor shall be responsible for completing and filing the Owner's shutdown notice questionnaire.
   5. Perform required survey and inspection work required by the notice for shutdown.

G. Provide all necessary material, tools, and labor as required for the provisions of temporary services.

H. Include premium time work associated with interruptions of services and/or shutdowns as necessary to avoid disruption to Owner's operations.

I. For communications work associated with any service provider, coordinate with the appropriate service provider.

J. Complete the following form, indicating what is being included as part of this bid, and this project.

K. For work involving an independent utility company (i.e., non-owner provided utility), Contractor shall coordinate directly with the utility provider all aspects of related work, including shutdowns, tie-ins, capacity impacts, etc.

1.18 MATERIALS AND EQUIPMENT

A. Materials and equipment required shall be new unless specifically permitted otherwise on the drawings.

B. Equipment supplied shall be based on materials and equipment of manufacturers specified. No substitutions are allowed except as permitted in this specification.

C. Items specified shall be the latest type or model produced by the manufacturer specified. If descriptive specification or model number is obsolete, substitute the current product.

1.19 PROTECTION OF WORK

A. Each low voltage contractor shall be responsible for his work and equipment until finally inspected, tested, and accepted. Carefully store materials and equipment, which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material.

B. Each separate contractor shall protect the work and material of other trades that might be damaged by his work or workmen and make good all damage thus caused.

1.20 SUBSTITUTIONS

A. Substitutions shall not be allowed. Where the Low Voltage Contractor wishes to use equipment or methods other then those listed by name, that equipment must be approved by the Engineer. To gain approval for equipment not listed, the Low Voltage Contractor shall submit the following to the Engineer for his review:
   1. Documentation from the equipment manufacturer indicating where this equipment meets and does not meet the specifications or drawings as written. This documentation shall state exceptions taken to the specification and the reasons for exceptions. Documentation relative to the request shall be submitted on the manufacturer's letterhead and signed by a representative of the manufacturer.

2. Manufacturer's Cut Sheets: Cut sheets shall be originals as are contained in the manufacturer's catalog. Photocopies of these sheets will not be accepted for review. (Furnish 3 copies.)
3. The Low Voltage Contractor shall provide samples of the proposed equipment for the Engineer's review, if requested by the Engineer.
4. The Low Voltage Contractor shall furnish other information or materials as requested by the Architect/ Engineer to establish equality.
5. The Low Voltage Contractor shall acknowledge that they have reviewed the submission criteria for the request by stamping the submission with a review stamp or acknowledgement by an accompanying letter.
6. Equipment and materials submitted for review without proper documentation shall be rejected without review.

B. Submittal, including samples, shall be received in the Engineer's office prior to bidding.

C. Materials, equipment, or methods of installation other than those named, shall be in accordance with the general requirements and similar in composition, dimension, construction, capacity, finish and performance.

D. Low Voltage Contractors submitting equipment for approval shall include in their bids incidental costs that may result from the use of equipment. Costs shall include, but not be limited to, additional costs that may be incurred by other contractors whose scope of work is affected by use of the product. The Low Voltage Contractor shall be responsible for those costs even if they do not become evident until after bidding.

1.21 SUBMITTALS

A. Definitions:
1. Shop Drawings are information prepared by the Low Voltage Contractor to illustrate portions of the work, such as ductwork layout arrangements, in more detail than shown in the Contract Documents.
2. Submittals are a compilation of product data cutsheets fully describing performance, size, connections, color selection, etc., as provided by the manufacturer.

B. Submittal Procedures and Format
1. Review submittal packages for compliance with Contract Documents and then submit to Architect for review. Submit reproducible drawing and two blue- or black-line reproductions of each Shop Drawing larger than 8-1/2 x 11. Submit four sets of each smaller shop drawing. After review, reproducible original of each large Shop Drawing and three sets of each small shop drawing will be returned with reviewer's marks.
2. Submittals and shop drawings shall be submitted COMPLETE, by trade, in heavy-duty three-ring binders. Each binder shall include a Table of Contents identifying each section. Each section shall be arranged in order of specification section and tabbed accordingly. Each item submitted shall reference the article and paragraph of its specification section. Each item specified shall be addressed. If specified item will not be used, state so in submittal with brief explanation. In the instance when a resubmission is necessary, resubmit only the items required; a complete resubmittal containing previously approved data is not required.
3. Provide additional copies of approved submittals/shop drawings as required for full distribution.
4. Shop Drawings showing layouts of systems shall contain sufficient plans, elevations, sections, details and schematics to describe work clearly. They shall be 1/4 inches = 1 foot 0 inch scale unless specified otherwise.
5. Shop drawings and submittals showing manufacturer's product data shall contain detailed dimensional drawings, accurate and complete description of materials of construction, manufacturer's published performance characteristics and capacity ratings (performance data, alone, is not acceptable), electrical requirements and wiring diagrams. Drawings shall clearly indicate location (terminal block or wire number), voltage and function for all field

terminations, and other information necessary to demonstrate compliance with all requirements of Contract Documents.

C. Required Use of Acceptable Manufacturers on this Project:
   1. Substitution of products other than those of the Acceptable Manufacturers specified herein shall not be made. Only the specified items or the comparable product by one of the specified Alternate Manufacturers shall be submitted. Products by other manufacturers shall not be used on this project.
   2. Listing of a manufacturer's name for a particular material or piece of equipment does not imply acceptance of all of that manufacturer's products. Use of more than one manufacturer to supply any specific material or equipment shall have prior approval of the Architect/Engineer.

D. Deviations
   1. Concerning deviations other than substitutions, proposed deviations from Contract Documents should be requested individually in writing whether deviations result from field conditions, standard shop practice, or other cause. Submit letter with transmittal of submittals/shop drawings which flags the deviation to the attention of the Architect.
   2. Without letters flagging the deviation to the Architect, it is possible that the Architect may not notice such deviation or may not realize its ramifications. Therefore, if such letters are not submitted to the Architect, the contractor shall hold the Architect and his consultants harmless for any and all adverse consequences resulting from the deviations being implemented. This shall apply regardless of whether the Architect has reviewed or approved submittals/shop drawings containing the deviation, and will be strictly enforced.
   3. Approval of proposed deviations, if any, will be made at the discretion of the Architect.
   4. Where equipment or methods different than those specified are submitted by this Low Voltage Contractor and approved for use by the Engineer and Owner, the installation shall be in full conformance with the intent of these Contract Documents. All costs related to the use of the different method and/or equipment shall be paid by this Low Voltage Contractor.

E. Responsibility
   1. Intent of Submittal review is to check for capacity, rating, and certain construction features. The Low Voltage Contractor shall ensure that work meets requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this and other Sections. Work shall comply with submittal notations to extent that they agree with Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of Contract Documents. The Architect's/Engineer’s noting of some errors while overlooking others will not excuse the Contractor from proceeding in error. Contract Documents requirements are not limited, waived nor superseded in any way by review.
   2. Inform subcontractors, manufacturers, suppliers, etc., of scope and limited nature of review process and enforce compliance with contract documents.
      a. The Engineer’s obligations to review shop drawings and other submittals and to return them in a timely manner are conditioned upon the prior review and approval of the shop drawings or submittals by the Low Voltage Contractor as required in the construction contract and the Low Voltage Contractor’s submittal of the shop drawings and other submittals in accordance with a written schedule distributed in advance to the Engineer identifying the dates for the submittal of the various shop drawings and submittals.

F. Schedule: Incorporate submittal review period into construction schedule so that Work is not delayed. The Low Voltage Contractor shall assume full responsibility for delays caused by not incorporating the following submittal review time requirements into his project schedule. Working days listed reference the time in the Engineer's office. It does not include transmittal or review time of Contractor or Architect. If more than five submittals/shop drawings of a single trade are

received in one week, allow at least five (5) additional working days, exclusive of transmittal time, for review, each time a submittal/shop drawing is submitted or resubmitted.

G. Multiple Re-submittals: The Engineer will review the first submittal from the low voltage contractor and respond with comments, and will review one re-submittal for the same item(s) from the contractor and respond with comments. If the contractor is required to make subsequent submittals for the same item(s) the Engineer shall be compensated by the contractor for the time to review each subsequent re-submittal.

H. All submitted product sheets containing more than one product or multiple product options shall have the submitted product clearly identified for review with all options highlight as intended for review.

1.22 SHOP DRAWINGS AND EQUIPMENT BROCHURES

A. Submit to Engineer for review, the manufacturer's shop drawings and equipment brochures in quantities determined by the Engineer and specified in the appropriate sections for the following:
   1. Section 270526 – Grounding and Bonding for Communications Systems
   2. Section 270528 – Pathways for Communications Systems
   3. Section 271100 – Communications Equipment Room Fittings
   4. Section 271300 – Communications Backbone Cabling
   5. Section 271500 – Communications Horizontal Cabling
   6. Section 281300 – Electronic Access Control

B. Data submitted for Engineer's review shall be numbered consecutively, shall be noted to correlate with the project drawings and shall bear:
   1. The name and location of the project.
   2. The name of the Contractor.
   3. The date of submittal.
   4. The date of the drawings and the date of each correction and revision.

C. Shop drawings for different systems and equipment shall, be bound separately by specification section and not bound by manufacturer. Submittals which contain different specification section systems bound together shall be returned unreviewed for resubmittal.

D. No materials or equipment subject to prior review by the Engineer shall be fabricated or installed by the Low Voltage Contractor, without approval. The Engineer's review of shop drawings shall not relieve the Low Voltage Contractor of responsibility for deviations from the requirements of the drawings and specifications, unless prior approval for deviations has been granted.

1.23 MAINTENANCE MANUALS

A. Obtain at time of purchase of equipment, three copies of operation and maintenance manuals for all items. Assemble literature in coordinated manuals with additional information describing combined operation of field assembled units, including as-built wiring diagrams. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment.

B. The manuals shall include the following and shall have an index of contents and tabs for each Specification Section and each piece of equipment specified in that Section and be provided in the order listed below, per Specification Section.
   1. Copies of all approved submittals/shop drawings.
   2. Manufacturer's operating and maintenance instructions and parts lists of all items or equipment. Where manufacturer's data includes several types or models, the applicable type or model shall be clearly designated.
   3. Riser diagrams.
   4. Wiring diagrams.
   5. Test records.
   6. Owner's written acknowledgement of satisfactory completion of instruction period.

C. The operation manuals and instructions to the Owner are of prime importance and shall be provided prior to request for final payment.

D. Furnish three copies of manuals to Architect for approval and distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner's personnel to become familiar with equipment and operation prior to acceptance.

E. Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct Owner's operating personnel in any or all parts of all systems. Factory-trained personnel shall perform instructions. Owner shall determine which systems require additional instructions. Duration of instructions shall take equipment through complete cycle of operation (at least five working days). Make adjustments under operating conditions.

F. If it is desired to provide maintenance manuals in PDF format, the low voltage contractor shall provide a written request prior to submitting the manuals indicating which equipment manuals they propose to provide in this format.

1.24 CLEANING AND PAINTING

A. Rubbish resulting from this work shall be removed and disposed of on a daily basis in manner as to be acceptable to the Architect.

B. The Low Voltage Contractor shall clean exposed work and equipment, the interior and exterior of cabinets and pull boxes, etc., and remove rubbish and debris resulting from the work.

C. Where painted surfaces of equipment have been damaged or rusted during construction, the Low Voltage Contractor shall repair and paint to match original finish.

D. Clean other equipment indicated in other sections of the specification for specific equipment.

E. Cleaning shall be performed prior to system start-up.

F. Equipment
   1. After completion of project, clean the exterior surface of all equipment, including concrete residue, dirt, paint residue, etc.

1.25 TESTS AND ACCEPTANCE

A. The operation of the equipment and communications systems does not constitute an acceptance of the work. The acceptance is to be made after the Low Voltage Contractor has adjusted his equipment and demonstrated that it fulfills the requirements of the drawings and the specifications.

B. Tests and Acceptance procedures shall adhere to those specified within each Division 26, 27 and 28 Specification Section.

C. Upon completion of the installation, the Low Voltage Contractor shall furnish certificates of approval from authorities having jurisdiction.

D. In the presence of the Engineer and the Owner, the Low Voltage Contractor shall demonstrate the proper operation of miscellaneous systems.

E. Perform other test as specifically stated in other sections of the specification for specific equipment.

1.26 GUARANTEE AND 24 HOUR SERVICE

A. Guarantee the Work of this Section in writing for one year following the date of Substantial Completion. If the equipment is used for ventilation, temporary heat, etc. prior to initial beneficial occupancy by the Owner, the bid price shall include an extended period of warranty covering the one-year of occupancy, starting from the initial date of beneficial occupancy by the Owner. The

guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to Architect's satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.

B. In addition to guarantee requirements of Division 1 and of Paragraph A above, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in Owner's name.

C. Replace material and equipment that require excessive service during guarantee period as defined and as directed by Architect.

D. Provide 24-hour service beginning on the date of Substantial Completion and lasting until the termination of the guarantee period. Service shall be at no cost to the Owner. This contractor or a separate service organization can provide Service. Choice of service organization shall be subject to Architect and Owner approval. Submit name and a phone number that will be answered on a 24-hour basis each day of the week, for the duration of the service.

E. Submit copies of equipment and material warranties to Architect as part of the close-out documents before final payment.

F. At end of guarantee period, transfer manufacturers' equipment and material warranties still in force to Owner.

G. This Article shall not be interpreted to limit Owner's rights under applicable codes and laws and under this Contract.

H. Specific Paragraphs of the Specification sections may specify warranty requirements that exceed those of this Article.

I. Use of systems provided under Division 26, 27 and 28 for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute guarantee period.

J. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise the Architect in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Architect will suggest course of action.

1.27 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.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. 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 location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access panels required by code or otherwise to electrical service equipment shall be supplied and installed by Electrical Contractor. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

1.28 SPARE PARTS

A. Requirements for spare parts are outlines in individual specification sections. Spare parts shall be turned over, unopened, to the Owner as part of the maintenance manual submittal.

1.29 OWNER TRAINING

A. As part of this contract, the contractor shall include all labor and materials to train the building Owner on the electrical systems installed.

B. Owner training shall adhere to the training specified in each Division 27 Specification Section.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to each specific Division 27 and 28 Communications specification section for specific details.

B. Perform work such that progress of the entire project including the work of other disciplines and Divisions shall not be interfered with or delayed.

2.02 SPECIAL RESPONSIBILITIES

A. Installation Only Items:
   1. Where the Low Voltage Contractor is required to install items which he does not purchase, he shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation.
   2. The Low Voltage Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this Contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted, this Contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

B. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions.

C. Use of premises: Use of premises shall be restricted as directed by Architect and as noted below.
   1. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Maintain building and premises in neat and clean condition, and perform cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of Architect.
   2. Store materials in a manner that will maintain an orderly, clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
   3. Do not interfere with function of existing sewers and water and gas mains, electrical or mechanical systems and services. Extreme care shall be taken to prevent debris from entering pipe, ductwork and equipment. Confer with Architect as to disruption of services or other utilities due to testing or connection of new work to existing. Interruption of services shall be performed at time of day or night deemed by Owner to provide minimal interference with normal operation. Obtain Owner's approval of the method proposed for minimizing service interruption.

2.03 FIRESTOPPING

A. Fire stopping materials shall include, but not be limited to, mortars, sealants and caulks, putties, collars, intumescent mastic wrap strips, and firestop pillows. Materials and methods used shall be recognized by an independent testing agency and shall have flame and temperature ratings assigned by that agency.

B. Materials using solvents or that requiring hazardous waste disposal shall not be used.

C. The firestop assemblies shall meet fire test and hose stream test requirements of an independent testing agency.

D. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for extra cost to Owner.

E. A single firestopping manufacturer shall be utilized throughout the project. The firestopping manufacturer shall be decided by the General Contractor. All products and methods used on the project for firestopping shall be approved by the General Contractor.

F. Typical Acceptable manufacturers:
   1. 3M Corporation.
   2. Hilti

2.04 SLEEVES FOR RACEWAYS AND CABLES

A. General:
   1. Lay out penetration and sleeve openings in advance, to permit provision in work. Set sleeves and conduit in forms before concrete is poured. Provide remedial work where sleeves and conduits are omitted or improperly placed.
   2. Provide sleeves and packing materials at all penetrations of foundations, walls, slabs (except on-grade), partitions and floors. Sleeves shall meet U.L. rated assembly requirements and materials requirements of these specifications.
   3. Sleeves that penetrate outside walls, basement slabs, footings and beams shall be waterproof.
   4. Coordinate work carefully with architectural and structural work. Provide core drilling as necessary if walls are poured or otherwise constructed, without sleeves and a wall penetration is required. Provide core drilling as required for penetrations of existing construction. Do not penetrate structural members without Structural Engineer’s/Architect's approval.
   5. Submit a list of the U.L. Listed details that the Contractor intends on using on this project, in all rated walls.
   6. Where sleeves/ cabling passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.
   7. Identify unused sleeves and slots for future installation.
   8. Fill slots, sleeves and other openings in floors or walls if not used. Fill spaces in openings after installation of pipe, duct, conduit or cable.
   9. Fill for floor penetrations shall prevent passage of water, smoke, fire, and fumes. Fill shall be fire resistant in fire floors and walls, and shall prevent passage of air, smoke and fumes.
   10. Sleeves through floors shall be watertight and shall extend 2 inches above floor surface.
   11. Submit and coordinate with all trades complete penetration layout drawings showing all openings in building structural members including floor slabs, walls, bearing walls, foundation walls, shear walls, roof penetrations, etc. Indicate and locate, by dimension, all openings that shall be sleeved. Drawings shall be approved by Structural Engineer prior to the preparation of any opening in a structural member. Provide 24 gauge galvanized steel sleeves for all walls, floors, including foundation, stem and exterior walls.
   12. All penetrations into libraries, auditoriums, conference rooms, sleep rooms, etc., must utilize an acoustical sealant in addition to any other sealants required for wall ratings.
   13. Contractor shall maintain complete integrity of all completed waterproofing, weatherproofing, fire rating, and penetrations during construction.

B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends with plastic bushing on each of the sleeve.

C. 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.

2.05 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Stainless 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.

B. Installation Testing, Listings and Approvals
1. Installation shall meet material manufacturer's recommendations exactly, particularly regarding safety, ventilation, removal of foreign materials and other details of installation. Dam openings as recommended. Remove flammable materials used for damming and forming seals in fire-rated construction.
2. Sleeve penetration methods shall be water- and gas-tight and shall meet requirements of ASTM E-119 Standard Methods of Fire Tests of Building Construction and Materials.
3. Fire-stop penetration seal methods and materials shall be FM-approved and UL-listed as applicable.
4. Inspect foamed sealant to ensure manufacturer's optimum cell structure and color ranges.

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

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.

F. Materials and Workmanship
1. Work shall be neat and rectilinear. Cabling shall run concealed except in communications rooms and areas where no hung ceiling exists. Install material and equipment as required by manufacturers. Installation shall operate safely, without undue wear, noise, vibration or corrosion. Work shall be properly and effectively protected, and pipe and duct openings shall be temporarily closed to prevent obstruction and damage before completion.
2. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation.

3. Finish of materials, components and equipment shall be as approved by Architect and shall be resistant to corrosion and weather as necessary.
4. The Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.

G. Delivery, Storage and Handling
1. Protect equipment/materials from damage during shipping, storage, handling and installation. Delivery equipment/materials to the site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
2. The Low Voltage Contractor shall provide for enclosed storage, when equipment/materials are stored on-site and prior to building "dry-in", to prevent any damage resulting from inclement weather or construction traffic. Sheet metal/specialties shall not be stored outdoors.
3. Equipment exposed to weather during shipping and/or storage on site shall be plastic shrink-wrapped by the manufacturer to prevent damage due to weather and road debris during transportation and thereafter while in storage awaiting installation.
4. Prevent dirt and construction debris from accumulating inside equipment (including pipe and conduit, ductwork, fittings, etc.).
5. Equipment/materials, stored or installed, found to be damaged shall be replaced with new by the Contractor, to the satisfaction of the Owner and at no additional expense. Do not store equipment with PVC material with exposure to direct sunlight.
6. Equipment/materials shall be handled and installed in accordance with manufacturer's instructions.

H. Provisions and Installation of Equipment
1. For all equipment installed external to the building whether on roofs, supports, grade, etc., the installation must comply with wind loading and impact requirements of the applicable codes for this project site.
2. All equipment being furnished on this project, shall be certified by the manufacturer that the equipment item meets the applicable seismic, wind, earthquake and hurricane impact requirements as set forth by the Authority Having Jurisdiction overseeing this project, and as defined in the following codes:
   a. International Building Code – Section 1621 "Earthquake Loads"
3. Compliance with the above Paragraphs 2 can be reduced and/or eliminated if the equipment being provided is located inside a structural building enclosure, designed by a licensed professional Architect and Structural Engineer.
4. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to satisfaction of Architect and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.

3.02 FIRESTOPPING

A. Openings in fire rated construction and annular spaces around conduits, cable trays, and other penetrating items shall be protected in accordance with NEC article 300-21. The fire rating of the protective seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the construction is maintained. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

B. Wall or floor penetrations openings shall be as small as possible.

C. Openings and annular spaces required by code to be protected shall be protected whether specifically indicated on the plans or not.

D. Installation of materials and assemblies shall be in strict accordance with the manufacturer's instructions.

3.03 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays 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 (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway 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 pathway 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 pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways 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 pathway or cable and sleeve for installing mechanical sleeve seals.

3.04 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.

3.05 DEMOLITION

A. Refer to all drawings for general description of areas requiring demolition.

B. Refer to General Contractor's/Construction Manager's Instructions for all existing equipment and materials that shall remain the property of the Owner.

C. Items of value which are not directed to be returned to the Owner shall become the property of the Low Voltage Contractor. Storage or sale of items on the project site is prohibited.

D. Protection: Ensure the safe passage of persons in and around the building during demolition. Prevent injury to persons and damage to property. Provide adequate shoring and bracing to prevent collapse. Immediately repair damaged property to the condition before being damaged. Take effective measures to prevent windblown dust.

E. Utilities: Maintain all utilities except those requiring removal or relocation. Keep utilities in service and protect from damage. Do not interrupt utilities serving used areas without first obtaining permission from the utility company and the Owner. Provide temporary services as required.

F. Except as noted otherwise, remove from the premises, all materials and equipment removed in the demolition work

3.06 PROJECT CLOSE-OUT PROCEDURE

A. Close-out documentation shall be provided at the end of the project. Close out documentation shall comply with each applicable Division 26, 27 and 28 Specification Section.

B. It shall be each Contractor's responsibility to personally hand-deliver all of the required project close-out checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off.

3.07 OWNER TRAINING

A. Owner training shall comply with the requirements specified in each Division 26, 27 and 28 Specification Section.

B. In general, training shall cover all aspects of the operation and human interface with the given system. Training shall include, but not be limited to;
   1. General description of the system and operating intent.
   2. Review and demonstration of all adjustments and programming available to the customer.
   3. Review of all system display screens and annunciation functions, both audible and visual.
   4. Review and demonstration of all required and recommended periodic system/equipment maintenance. Review shall include all required lockout and tagging procedures.
   5. Refer to individual specification sections for additional requirements associated with Owner training.

C. Training schedule shall be acceptable to the Owner and shall reflect the availability of Owner personnel. Schedule shall be provided 14 working days in advance of the first training session and shall be approved in writing by the Owner before final dates and times are set.

3.08 BID ALTERNATES

A. Submit with bid, alternate prices as hereinafter requested stating the total difference in price (add or deduct) from the total base bid amount.

B. Prices of Alternates shall be the total price without further addition, mark-up, subtraction, change, discount or other changes to determine the cost of work.

C. Each alternate price shall include provision of work, material, connections, installation, related work, electrical and plumbing connections, control interface work, accessories, testing, adjusting and balancing, freight, rigging, labor, profits, overhead and taxes, and all other items necessary to provide complete and functional installation as required by Contract Documents.

D. Alternate work shall in no way limit the provisions of the Contract Documents, nor change, reduce or limit the Contractor's responsibility to comply fully with the provisions of Contract Documents.

E. The Owner reserves the right to accept or reject any or all alternates.

F. In accepting an alternate, the Owner understands that the bidder has examined the Contract Documents and is aware of all adjustments of affected work necessary to accomplish the stated desired results, whether or not all such adjustments are described within the alternates.

END OF SECTION

SECTION 270526

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED WORK AND REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems

B. Section 260533 - Raceways and Boxes for Electrical Systems

C. Section 260543 - Underground Ducts and Raceways for Electrical Systems

D. Section 260544 - Sleeves and Sleeve Seals for Electrical Raceways and Cabling

E. Section 270500 – Common Work Results for Communications

F. Section 270526 – Grounding and Bonding for Communications Systems

G. Section 270528 – Pathways for Communications Systems

H. Section 271100 – Communications Equipment Room Fittings

I. Section 271300 – Communications Backbone Cabling

J. Section 271500 – Communications Horizontal Cabling

K. Section 281300 – Electronic Access Control Systems

1.03 SUMMARY OF WORK

A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the communications grounding and bonding system as described in the drawings and within this and all associated specification sections.

B. The drawings indicate the general route and locations of the grounding and bonding system. Data presented on the drawings is as accurate as preliminary surveys and planning can determine. Accuracy is not guaranteed and field verification of all dimensions, routing, etc. is required.

C. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

1.04 REFERENCES

A. ANSI/NFPA 70 – National electrical Code

B. NEMA VE 1-1998- Metallic Cable Tray Systems

C. NEMA VE 2-2000 – Cable Tray Installation Guidelines

D. NEC Compliance - (Article 318) Construction and Installation of Cable Tray

E. UL Compliance - Provide products that are UL-classified and labeled

F. BICSI Telecommunications Distribution Methods Manual

G. IEEE Standard 1100: IEEE Recommended Practice for Powering and Grounding Electronic Equipment (IEEE Emerald Book)

H. TIA/EIA: TIA-942 Telecommunications Infrastructure Standard for Data Centers

I. TIA/EIA: J-STD-607-A Commercial Building Grounding/ Bonding Requirements

J. TIA/EIA: TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

1.05 RESPONSIBILITY

A. The Electrical Contractor shall be responsible for providing each Telecommunications Main Grounding Busbar (TMGB) and Telecommunications Grounding Busbar (TGB). The Electrical Contractor shall be responsible for providing the connection between each TMGB and TGB and the building electrical grounding system.

B. The Electrical Contractor shall be responsible for providing the grounding and bonding materials and equipment to provide a complete grounding and bonding system for the telecommunications system and associated equipment.

C. The term Low Voltage Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.

D. The Low Voltage Contractor for this project shall be contracted by the General Contractor/Electrical Contractor.

1.06 DEFINITIONS

A. ACEG: Alternating Current Equipment Ground

B. BC: Bonding Conductor

C. BCT: Bonding Conductor for Telecommunications: A conductor that interconnects the telecommunications binding infrastructure to the building's service equipment (power) ground.

D. BICSI: Building Industry Consulting Service International.

E. Bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

F. CBN: Common Bonding Network

G. EF: Entrance Facility

H. EMI: Electromagnetic Interference

I. Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams and specifications.

J. ER: Equipment Room

K. GE: Grounding Equalizer

L. GEC: Grounding Electrode Conductor

M. LAN: Local area network.

N. MCBN: Mesh Common Bonding Network

O. RCDD: Registered Communications Distribution Designer.

P. TR: Telecommunications Room

Q. Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams and specifications.

R. Ground/Earth: A conducting connection, whether intentional or incidental, by which an electric circuit or equipment is connected to earth, or to some conducting body of relatively large extent that serves in place of the earth.

S. TBB: Telecommunications Bonding Backbone: A copper conductor used to connect the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar (TGB).

T. TGB: Telecommunications Grounding Busbar: The interface to the building telecommunications grounding system generally located in the telecommunications room or equipment room. A common point of connection for telecommunications system and equipment bonding to ground, and located in the telecommunications room or equipment room.

U. TMGB: Telecommunications Main Grounding Busbar: A busbar placed in a convenient and accessible location and bonded, by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

1.07 BIDDING

A. At the time of bid, in addition to a complete bid including all pricing information, provide the following:
   1. A detailed description of any and all additions, deletions or exceptions taken to the bid documents. Include the reasons why changes are being proposed.
   2. Detailed breakout of all requested alternate pricing.
   3. A price to furnish and install each individual media type and system component under this proposed work.
   4. Manufacturer's original equipment cut sheets for each product for use on this project, refer to Submittals for a complete explanation of required cut sheets and technical product information.
   5. Any add/delete pricing requested.

1.08 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and technical data/ cut sheets for each piece of equipment, cable and connector required to provide a complete grounding and bonding system. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For the communications grounding and bonding system. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, location and size of each field connection.
   2. Wiring Diagrams to show typical grounding and bonding schemes including the following:
      a. Locations of Telecommunications Main Grounding Busbars
      b. Locations of Telecommunications Grounding Busbars
      c. Typical grounding topology within equipment rooms and telecommunications rooms
      d. Telecommunications Bonding Backbone topology including bonding conductor sizes
   3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.09 QUALITY ASSURANCE

A. Installer Qualifications: Low Voltage Contractor must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of Commercial Installer, Level 2.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician who shall be present at all times when Work of this Section is performed at Project site.

3. Field Inspector: Currently registered by BICSI as Commercial Installer to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A and BICSI's Telecommunications Distribution Methods Manual.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install grounding and bonding equipment until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.11 PERFORMANCE REQUIREMENTS

A. The grounding/earthing and bonding system shall create a low impedance path with adequate capacity for electrical surges and transient voltages to return to their source (which may include the earth). This specification focuses on the telecommunications grounding and bonding system, hereafter referred to as the grounding, bonding, or grounding/earthing system.

B. The grounding/earthing system must be intentional, visually verifiable, adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment.
   1. Always follow the grounding/earthing recommendations of the manufacturer when installing equipment.
   2. Bonding to building steel and metallic water piping shall not be substituted for the telecommunications bonding backbone (TBB).
   3. Electrical continuity throughout each rack or cabinet is required to minimize safety risks. Hardware typically supplied with bolt-together racks is not designed for grounding/earthing purposes. Additionally, most racks and cabinets are painted. Paint is an insulator. Unless rack and cabinet members are deliberately bonded, continuity between members is incidental, and in many cases, unlikely.
   4. Any metallic component that shall be considered part of the telecommunications system, including but not limited to equipment, equipment racks/ cabinets, cable pathways (ladder racks, wire cable basket tray), enclosures, etc. All telecommunications system components shall be bonded to the grounding/earthing system.

C. Telecommunications systems shall be grounded and bonded in compliance with the requirements and practices of the NEC, except where other codes or authorities have more stringent requirements including applicable ANSI J-STD-607-A, Commercial Building Grounding and Bonding Requirements for Telecommunications and Local Building Codes.

1.12 COORDINATION

A. Coordinate layout and installation of communications grounding and bonding equipment with Owner's telecommunications LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
   1. Meet jointly with Owner's telecommunications, LAN equipment suppliers, local exchange carrier representatives to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.

B. Coordinate the location of the Telecommunications Main Grounding Busbar, Telecommunication Grounding Busbar and Telecommunication Bonding Backbone with the Electrical Contractor.

C. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.01 STANDARD BUSBARS

A. Acceptable Manufacturers:
   1. Chatsworth Products, Inc.
   2. Ortronics, A Legrand Company
   3. Panduit

B. General:
   1. Standard Busbars are insulated ground bus mounting plates specifically designed for commercial applications.
   2. Standard Busbars shall be constructed of Hard-Drawn Electrolytic Tough Pitch 110 Alloy solid copper.
   3. Standard Busbars shall be UL Listed, and meet BICSI and J-STD-607-A requirements for network systems grounding applications..

C. Size:
   1. Telecommunications Main Grounding Busbar (TMGB)
      a. The TMGB shall be 1/4 inch thick and 4 inches wide and stand-off 2.75 inches from the backboard or wall.
      b. The TMGB shall be available in standard lengths of 12 inches.
      c. Each 12 inch TMGB shall include a minimum of (12) 1/4 inch and (6) 3/8 inch inch holes.
      d. Each TMGB shall accept any lug with a 3/8 inch bolt.
   2. Telecommunications Grounding Busbar (TGB)
      a. The TMGB shall be 1/4 inch thick and 2 inches wide and stand-off 2.75 inches from the backboard or wall.
      b. The TMGB shall be available in standard lengths of 10 inches.
      c. 10 inch TGB shall include a minimum of (4) 1/4 inch and (3) 3/8 inch holes.
      d. Each TMGB shall accept any lug with a 3/8 inch bolt.

2.02 VERTICAL EQUIPMENT RACK BUSBAR

A. Acceptable Manufacturers:
   1. Chatsworth Products, Inc.
   2. Ortronics, A Legrand Company
   3. Panduit

B. General:
   1. Vertical rack busbars provide a vertical ground continuity path between equipment along an equipment rack or cabinet face.
   2. Vertical rack busbars shall be constructed of Hard-Drawn Electrolytic Tough Pitch 110 Alloy solid copper.
   3. Vertical rack busbars shall be UL Listed.

C. Size:
   1. Each vertical rack busbars will be 5/8 inch wide and 1/4 inch wide. Each vertical rack busbar shall bond a minimum of 45 standard EIA/ TIA rack units (RU).
   2. Each vertical rack busbars shall include pairs of #1/4-20 tapped mounting holes on 5/8 inch centers.
   3. Vertical rack busbars shall have standard lengths of 36 and 72 inches as per specifications.
   4. 36 and 72 inch Vertical Rack Busbars shall except two sets of #5/16 self-clinching studs on 1 inch centers at both ends for attachment of a ground conductor.

2.03 CABLE RUNWAY GROUND STRAP

A. Acceptable Manufacturers:
   1. Chatsworth Products
   2. Ortronics, a Legrand Company
   3. Panduit

B. General:
   1. Cable runway ground strap provide a ground pathway between cable pathway segments/ runway lengths when fastened together across pathway/ runway splices.
   2. Cable runway ground straps shall be constructed of UL Listed components.

C. Size:
   1. Each cable runway ground strap shall consist of a minimum 8-inch long #6 AWG green/ yellow insulated stranded copper conductor attached at both ends to two-hole compression lugs.
   2. Each compression lug at each end of the conductor shall include two 1/4 inch bolt holes spaced on 5/8 inch centers.

2.04 GROUND JUMPER

A. Acceptable Manufacturers:
   1. Chatsworth Products
   2. Ortronics, a Legrand Company
   3. Panduit

B. Ground Jumpers provide common grounding from the equipment, equipment rack or cabinet to the halo conductor, grounding strip or grounding busbar.

C. Ground Jumpers shall be constructed of #6 AWG green/ yellow insulated stranded copper conductor attached to a compression lug at each end.

D. Each compression lug at each end of the conductor shall include two 1/4 inch bolt holes spaced on 5/8 inch centers. Compression lugs shall be available with 90° angles.

E. Ground jumper shall be available in lengths as required.

F. Constructed of UL Listed components.

2.05 TWO MOUNTING HOLE GROUND TERMINAL BLOCK

A. Acceptable Manufacturers:
   1. Chatsworth Products
   2. Ortronics, a Legrand Company
   3. Panduit

B. Terminal blocks shall provide a method for attaching ground wires to racks or cabinets.

C. Terminal blocks shall be constructed of extruded, high-strength aluminum.

D. Terminal blocks shall accept conductors from #14 AWG through 2/0 AWG.

E. Each terminal block shall include two #3/8-24 x 7/8 inch stainless steel hex head set screws.

F. Terminal blocks shall be UL Listed and meet BICIS and ANSI/EIA/TIA two hole mounting recommendations.

2.06 CODE/ FLEX CONDUCTOR TAP

A. Acceptable Manufacturers:
   1. Chatsworth Products
   2. Ortronics, a Legrand Company
   3. Panduit

B. Code/ Flex conductor taps shall be provide a method for tapping into continuous conductors as a splice or pigtailing.

C. Each tap shall support runs of #6 - #10 AWG and taps of #2 - #6 AWG and #8 - #14 AWG.

D. Each tap groove shall be constructed separately from one another to allow each groove to function independently of one another.

E. Taps shall be UL Listed and CSA Certified with AWG conductors for applications up to 600V.

F. Clear high impact plastic cover shall be provided with each tap and shall meet the following requirements:
   1. Each cover shall allow complete 360° inspection of the crimp connection to assure that the crimp was made properly.
   2. Each cover shall allow labels to be added to and protected by either side of the cover.
   3. Each cover shall include molded flash barriers encompassing the tap and crimp to provide protection against electrical flash over.
   4. The high impact plastic shall meet the UL 94V-0 flame rating and oxygen index of 28 providing self extinguishing, flame retardant properties.
   5. Each cover shall include the part number, voltage rating, and temperature rating molded into the cover.

2.07 U-BOLT STYLE GROUNDING CLAMP

A. Acceptable Manufacturers:
   1. Chatsworth Products, Inc (CPI)
   2. Ortronics, a Legrand Company
   3. Panduit

B. U-bolt style grounding clamps shall provide a method to ground copper conductors to rods, tubes or pipes at parallel or right angle.

C. U-bolt clamps shall be constructed from high strength, electrolytic cast bronze.

D. U-Bolt clamps hardware shall be constructed from high strength silicon bronze hardware.

E. U-Bolt clamps shall be UL Listed for grounding and bonding with AWG conductors and suitable for direct burial in earth or concrete.

F. U-bolt clamps shall accept the following pipe sizes: 3/4 inch, 1 inch and the following ground rod sizes: 1 inch

G. U-bolt clamps shall accept the following conductor sizes: #8 SOL - #4 STD AWG

PART 3 - EXECUTION

3.01 GROUNDING/EARTHING AND BONDING

A. A Telecommunications Main Grounding Busbar (TMGB) shall be located at the service entrance. A Telecommunications Grounding Busbar (TGB) shall be located in each telecommunications space. The TGB will be grounded/earthed to the Telecommunications Main Grounding Busbar (TMGB).

B. The TMGB shall be bonded to building steel and grounded/earthed to the electrical service ground according to J-STD-607-A guidelines. Each TGB shall be bonded to building steel and the electrical panel serving equipment in the telecommunications space.

C. The gauge of the connecting ground/earth cable, known as the Telecommunications Bonding Backbone (TBB) will follow J-STD-607-A guidelines, as is shown in the table below.

Sizing of the TBB	
TBB Length in Linear meters (feet)	TBB Size (AWG)

Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
Greater than 20 (66)	3/0

D. Route the TBB to each TGB in as straight a path as possible. The TBB should be installed as a continuous conductor, avoiding splices where possible. When more than one TBB is used, bond them together using the TGBs on the top floor and every third floor in between with a conductor known as a grounding equalizer (GE). Use the J-STD-607-A guidelines for sizing of the TBB when sizing the GE (shown in the table above).

3.02 CONSTRUCTION OF THE GROUNDING/EARTHING SYSTEM

A. Avoid routing grounding/earthing conductors in metal conduits. If the grounding/earthing conductor must be routed through a metal conduit, bond each end of the conduit to the grounding/earthing conductor. Use u-bolt style grounding clamps to bond to the conduit, a copper compression fitting with clear cover to bond to the grounding/earthing conductor, and a #6 AWG copper conductor to connect the u-bolt style grounding clamp to the compression fitting.

B. In telecommunications spaces with a small number of racks or cabinets, it may be most convenient to bond the grounding/earthing jumper cable directly to the TGB. Larger spaces require a Mesh Common Bonding Network, as described below.

Cable Sizes for Other Grounding/Earthing Applications Not Specifically Described Elsewhere in This Document	
Purpose	Copper Code Cable Size
Aisle grounds (overhead or under floor) of the common bonding network	#2 AWG
Bonding conductor to each PDU or panel board serving the room.	Size per NEC 250.122 & manufacturer recommendations
Bonding conductor to HVAC equipment	#6 AWG
Building columns	#4 AWG
Cable ladders and trays	#6 AWG
Conduit, water pipe, duct	#6 AWG

3.03 RETROFIT RACK GROUNDING/EARTHING

A. If the racks already have network equipment installed, it may not be feasible to install the rack ground strip without disrupting data cables. Further, it may be undesirable to disassemble rack hardware to install paint piercing grounding washers, or in some cases, the construction of the rack may make grounding washer installation impossible. In these circumstances horizontal equipment rack busbars are to be installed.

B. Use the following components to attach the rack ground strip to the mesh CBN: A #6 AWG cable with one factory installed two-hole lug and hardware to connect to the busbar and one copper compression tap to connect to the mesh CBN. Do not bond racks or cabinets serially. Bond each ground jumper conductor directly to the mesh common bonding network.

C. Provided a #6 AWG grounding jumper to ground/earth each equipment chassis mounted in the equipment rack to the horizontal equipment rack grounding busbar provided as is shown in figure 5 below.

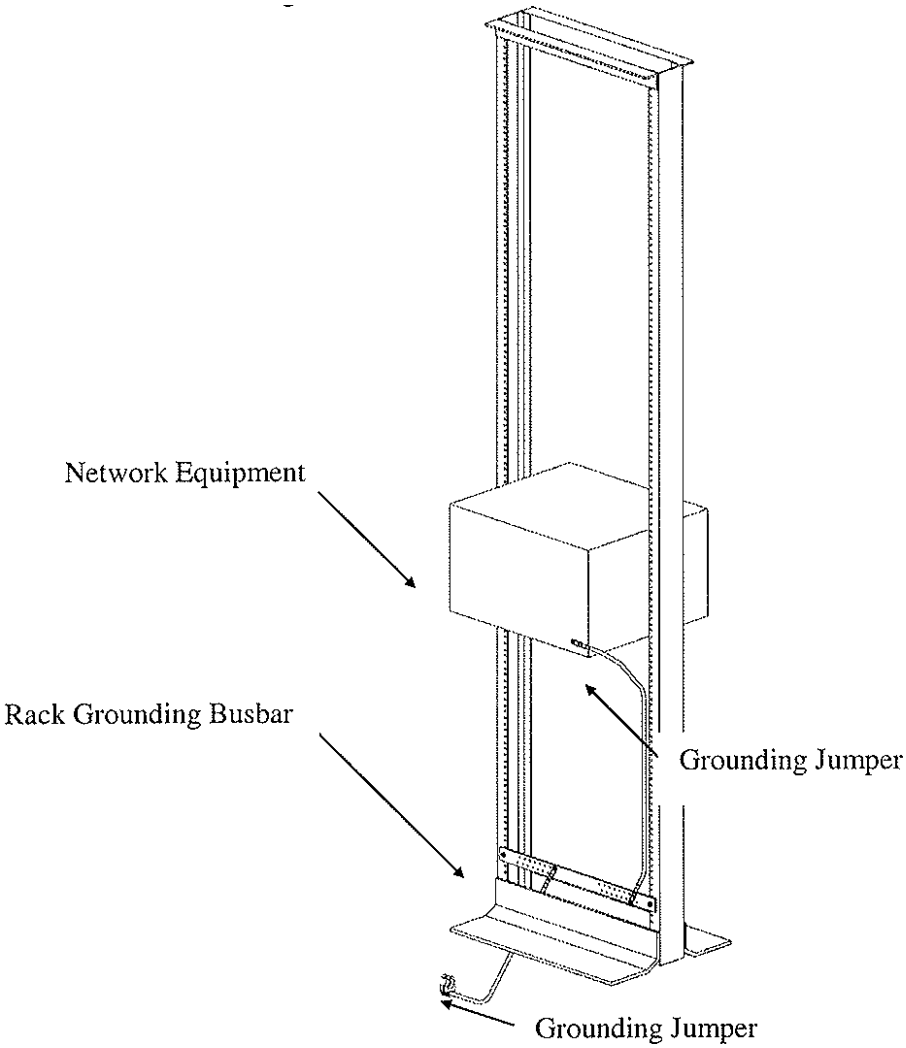

Figure 5 - Retrofit Rack Grounding/Earthing

3.04 RETROFIT CABINET GROUNDING/EARTHING

A. If the cabinets already have network equipment installed, it may not be feasible to install the rack ground strips without disrupting data cables. In these cases the rack ground strip would not be used and equipment jumpers would be used to make the bond between network equipment and the busbar. Refer to Figure 6 for details.

B. All other grounding/earthing requirements apply to retrofit installations without exception.

3.05 GROUNDING SYSTEM

A. The communications grounding system shall be designed and/or approved by a qualified PE, licensed in the state that the work is to be performed. The communications grounding system shall adhere to the recommendations of the ANSI/TIA-942 and J-STD-607-A standards, and shall be installed in accordance with best industry practice.

B. A licensed electrical contractor shall perform installation and termination of the main bonding conductor to the building service entrance ground.

3.06 WORKMANSHIP

A. The ground/earth system must be designed for high reliability. Therefore, the grounding/earthing system shall meet following criteria:
   1. Local electrical codes shall be adhered to.
   2. The grounding/earthing system shall comply with ANSI/TIA-942 and J-STD-607-A.
   3. All grounding/earthing conductors shall be copper.
   4. Lugs, copper compression taps, grounding strips, and busbars shall be UL Listed and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.
   5. Wherever possible, two-hole lugs shall be used because they resist loosening when twisted (bumped) or exposed to vibration. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion (battery rooms are an exception where windowless lugs may be used).
   6. Die index numbers shall be embossed on all compression connections to allow crimp inspection.
   7. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.

3.07 PENETRATIONS OF WALLS, FLOORS AND CEILINGS

A. Prior consent
   1. The Low Voltage Contractor shall make no penetration of floors, walls or ceiling without the prior consent from **exp** U.S. Services Inc.

B. Sealing penetrations – The area around the exterior of the sleeve shall be sealed by the contractor who installed the sleeve, the area internal to the sleeve shall be sealed by the Low Voltage Contractor who pulled or placed the cables.
   1. Where penetrations through acoustical walls or other walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor in compliance with applicable code requirements and as directed by Owner's Architect or General Contractor.
   2. Where penetrations through fire-rated walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor as required by code and as directed by Owner's Architect or General Contractor.

3.08 COMPLETION OF WORK

A. At the completion of the Work, the Low Voltage Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract.

B. All clean up, restoration, and removal noted above will be by the Low Voltage Contractor and at no additional cost.

C. If the Low Voltage Contractor fails in its duties under this paragraph, Owner may upon notice to the Low Voltage Contractor perform the necessary clean up and deduct the costs there of from any amounts due or to become due to the Low Voltage Contractor.

END OF SECTION

SECTION 270528

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED WORK AND REQUIREMENTS

A. Section 260526 - Grounding and Bonding for Electrical Systems

B. Section 260533 - Raceways and Boxes for Electrical Systems

C. Section 260543 - Underground Ducts and Raceways for Electrical Systems

D. Section 260544 - Sleeves and Sleeve Seals for Electrical Raceways and Cabling

E. Section 270500 – Common Work Results for Communications

F. Section 270526 – Grounding and Bonding for Communications Systems

G. Section 270528 – Pathways for Communications Systems

H. Section 271100 – Communications Equipment Room Fittings

I. Section 271300 – Communications Backbone Cabling

J. Section 271500 – Communications Horizontal Cabling

K. Section 281300 – Electronic Access Control Systems

1.03 SUMMARY

A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, and services to completely execute the horizontal cable pathway system of non-continuous cable supports, conduit or cable tray as described in the drawings.

B. The drawings indicate the general route of the raceway system. Data presented on the drawings is as accurate as preliminary surveys and planning can determine. Accuracy is not guaranteed and field verification of all dimensions, routing, etc. is required.

C. Specifications and drawings are for assistance and guidance, but exact routing, locations, distances and levels will be governed by actual field conditions. Contractor is directed to make field surveys as part of his work prior to submitting system layout drawings.

D. Section Includes:
   1. Metal conduits and fittings.
   2. Nonmetallic conduits and fittings.
   3. Cable pathways, supports and fittings.
   4. Boxes, enclosures, and cabinets.

1.04 REFERENCES

A. ANSI/NFPA 70 – National Electrical Code (NEC) 2008

B. ASTM B633 – Specification for Electrodeposited Coatings of Zink on Iron and Steel

C. ASTM A653 – Specification for Steel Sheet, Zink-Coated (Galvanized) by the Hot Dip Process

D. ASTM A123 – Specification for Zink (Hot Galvanized) Coatings on Iron and Steel

E. ASTM A510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel

F. ASTM A 641 – Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

G. ASTM A 580 – Standard Specification for Stainless Steel Wire

H. ASTM D 769 – Standard Specification for Black Oxide Coatings

I. NEMA VE 1-2002 – Metal Cable Tray Systems

J. UL Compliance - Provide products that are UL-classified and labeled

K. ANSI/TIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces

L. ANSI J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

M. BICSI Telecommunications Distribution Methods Manual

1.05 DEFINITIONS

A. ARC: Aluminum Rigid Conduit.

B. EMT: Electrical Metal Tubing

C. Engineer of Record: The engineer and engineering company that developed these contract documents, including the plans, diagrams and specifications.

D. GRC: Galvanized Rigid Conduit.

E. IMC: Intermediate Metal Conduit.

F. PVC: Polyvinyl Chloride Conduit

G. RMC: Rigid Metal Conduit.

1.06 DESCRIPTION

A. This system consists of empty raceways as shown on the drawings and described herein.

B. Horizontal pathways consist of structure that conceal, protect, support and provide access to horizontal cables between the telecommunication outlet/connector at the work area and the horizontal cross-connect in the serving area.

C. Where ceiling areas are used as pathways for telecommunication cables and connecting hardware follow all applicable rules covering installations in both air plenums and non-plenum hollow-ceiling systems as found in the applicable electrical and building codes and standards.

1.07 RESPONSIBILITIES

A. Responsibility for providing all equipment and associated support, splice, terminating hardware, etc. as necessary to provide a complete and functional cable support system.

B. The Electrical Contractor shall be responsible for providing all back-boxes, pull-boxes, junction boxes, conduit, and sleeves as indicated in the plans and specifications to support the low voltage systems

C. The contractor installing cable pathways shall be responsible for coordinating installation with general contractor and other trades on the job to insure pathways are not impeding other systems.

1.08 ACTION SUBMITTALS

A. Product Data
   1. Provide manufacturer’s catalog information showing dimensions, colors, and configurations.
   2. Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:
      a. Continuous and non-continuous cable pathway and fittings

b. All boxes and enclosures.

3. All submitted product sheets containing more than one product or multiple product options shall have the submitted product clearly identified for review with all options highlight as intended for review.

B. Shop Drawings:
1. For custom enclosures and boxes. Include plans, elevations, sections, and attachment details.
2. Cable pathway (continuous and non-continuous) layout, showing cable pathway route to scale, with relationship between the pathway and adjacent structural, electrical, and mechanical elements. Include the following:
a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to side of cable pathways.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

1.09 QUALITY ASSURANCE

A. Installer Qualifications: Low Voltage Contractor must have personnel certified by BICSI on staff.
1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as Commercial Installer, Level 2 to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with ANSI/TIA-569-B and BICSI's Telecommunications Distribution Methods Manual.

D. Grounding: Comply with NEC, the Authority Having Jurisdiction and ANSI-J-STD-607-A.

1.10 COORDINATION WITH OTHER TRADES

A. Coordinate the support of cable pathways support systems with the work of other trades.

B. Coordinate routing of cable pathways with the work of other trades to maintain adequate working clearances above, below and to the sides of cable pathways.

C. Coordinate with other contractors during the installation coordination meetings to provide input on shared hangers planned for use to support cable pathway systems.

PART 2 - PRODUCTS

2.01 BOXES AND ENCLOSURES

A. Acceptable Manufacturers:
1. Cooper Technologies Company; Cooper Crouse-Hinds.
2. Hoffman; a Pentair company.
3. Hubbell Incorporated; Killark Division.
4. RACO; a Hubbell company.
5. Wiremold / Legrand.

B. General Requirements for Boxes and Enclosures:
1. Comply with ANSI/TIA-569-B.

2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Boxes: Comply with NEMA OS 1 and UL 514A.

D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Typical Device Box Dimensions: 4-11/16 inches square by 2-1/8 inches deep unless otherwise noted.

G. Gangable boxes are allowed.

H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

I. Enclosures:
   1. Comply with UL 50 and NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   3. Nonmetallic Enclosures:
      a. Material: Plastic.
      b. Finished inside with radio-frequency-resistant paint.
   4. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
   5. Fully hinged door in front cove with flush latch and concealed hinge.
   6. Keyed latch to match equipment racks/ cabinets.
   7. Metal barriers to separate wiring of different systems and voltage.
   8. Accessory feet where required for freestanding equipment.
   9. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.02 CONDUITS/SLEEVES

A. General
   1. Conduit/sleeve shall be EMT grade metallic conduit schedule 5 or heavier.
   2. Any conduit/sleeve installed for communication cabling shall have a coupler on each end with a plastic bushing for cable protection.
   3. Terminate metal conduit using connectors with plastic bushings.
   4. Provide nylon or plastic pull strings in all conduit runs.

B. Fire Wall Penetrations
   1. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section “Penetration Firestopping.”
   2. Fire stop penetrations seal methods and materials shall be FM-approved and UL listed as applicable and as approved by the authorities having jurisdiction.
   3. All sealing systems and methods shall be submitted to exp U.S. Services Inc for review prior to installation and sealing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. In finished areas, provide concealed conduits and flush mount boxes.

B. All exposed conduit, junction boxes and supporting hardware shall be painted to match structure.

C. Conduit installation shall be coordinated with their respective termination equipment layouts at each backboard location as required to provide adequate dedicated space for the mounting of equipment for each system identified on the plans.

D. Cable pathway systems shall be supported by support systems specifically designed and manufactured for the support of cable pathway systems. The cable pathway systems shall not be supported by other installed building systems.

E. Install all pathway systems as per manufacturers recommended practices and as per local governmental regulations and NEC, and BICSI regulations and practices.

F. All cable pathway routes are to be parallel and/or perpendicular with the outside walls of the building. Alternate paths must be approved by the engineer of record prior to installation of the cabling.

G. Grounding and Bonding
   1. Ground conduits at terminal boards with grounding bushings.
   2. Wire basket tray shall be bonded directly to the TMGB or TGB in the telecommunications equipment room that the wire basket tray originates.
   3. Provide and install a grounding conductor routed through the entire run of all wire basket tray. The grounding conductor shall be bonded to each individual piece of cable basket tray.
      a. Any splices in the grounding conductor shall be protected, readably visible and accessible upon completion of the cable installation.
      b. Refer to specification section “Grounding and Bonding for Communication Systems” for grounding conductor requirements and sizing.

H. Cable pathways
   1. A dedicated pathway shall be provided for each low voltage communications cabling sub-system, included but not limited to structured cabling systems, security systems, [and low voltage control systems.
   2. Cable pathways supporting multiple low voltage communications cabling sub systems shall be divided into dedicated sections for each cabling sub system.
   3. Coordinate locations and sizes with each system’s Electrical Contractor, General Contractor and the Owner’s representative.

I. Conduit/ Sleeves
   1. Any section of conduit longer than 150 feet or containing more than 180 total degrees of bends shall have pull boxes. The contractor shall identify the pull box location(s) on submitted shop drawings for the Architect and Engineer to review.
   2. Each conduit bend shall be a long sweep radius wherever possible. In no instance shall the inside radius or bend be less than six (6) times the internal diameter of the conduit for conduits that are 2” in diameter or less, for conduits larger than 2” the bend radius shall be no less than 10 (ten) times the inside diameter.
   3. All communications sleeves shall be of a sized to accommodate the appropriate NEC fill ratios and comply with UL system requirements in rated penetration instances.
   4. All sleeves shall be of a size as to not have more than 40% of the sleeve filled with low voltage cable at the completion of the installation. Provide a minimum of 50% capacity for future growth (minimum of one open sleeve) at each sleeve location.
   5. All conduits/sleeves shall be secured and strapped to building surfaces per National Electric Code Article 358.30 (A) and (B).

J. Pull Boxes
   1. All pull boxes installed in low voltage communications conduit runs shall be sized per NEC or Table 4.7 of the BICSI Telecommunications Distribution Methods Manual, which ever requirement results in a larger pull box.
   2. Provide dedicated space encompassing pull box to permit access for installing and maintaining cables. Refer to Section 3.02 below for specific clearances required.

K. Firestopping
   1. Comply with requirements in Division 07 Section "Penetration Firestopping" and ANSI/TIA-569-B.

2. Responsibility for sealing of opening around the exterior of the low voltage system sleeves shall be by the contractor as described below:
    a. Sleeves through fire rated and smoke walls created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
    b. Sleeves through fire rated and smoke walls created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor.
    c. Sleeves of openings between floors created by the Low Voltage Contractor for cable pass through shall be the responsibility of the Low Voltage Contractor.
    d. Sleeves of openings between floors created by the Electrical Contractor for cable pass through shall be the responsibility of the Electrical Contractor**.**
3. Sealing of the space internal to all sleeves or openings specifically designated for telecommunications cabling shall be the responsibility of the Low Voltage Contractor.
4. Sealing material and application of this material shall be accomplished in such a manner which is acceptable to the local fire and building authorities having jurisdiction over this work.

L. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.02 CLEARANCES AROUND CABLE PATHWAYS

A. Clearances shall be provided around all cable pathways to provide continuous access to the cable pathway during and following the installation process. Coordinate required clearances with all other trades prior to beginning work.

B. Provide a minimum clearance of 24” in front of each pull box location.

END OF SECTION

SECTION 271100

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED WORK AND REQUIREMENTS

A. Section 270500 – Common Work Results for Communications

B. Section 270526 – Grounding and Bonding for Communications Systems

C. Section 270528 – Pathways for Communications Systems

D. Section 271300 – Communications Backbone Cabling

E. Section 271500 – Communications Horizontal Cabling

F. Section 281300 – Electronic Access Control Systems

1.03 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic even.

1.05 SUBMITTALS

A. Refer to Division 01, “General Requirements” and Section 270500, “Common Work Results for Communications” for general Submittal information and requirements.

B. Action Submittals
   1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
      c. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

3. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.
4. All submitted product sheets containing more than one product or multiple product options shall have the submitted product clearly identified for review with all options highlight as intended for review.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Low Voltage Contractor must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of Commercial Installer, Level 2.
   2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
   3. Field Inspector: Currently registered by BICSI as Commercial Installer, Level 2 to perform the on-site inspection.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A and BICSI's Telecommunications Distribution Methods Manual.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.08 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
   1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute them to other participants.
   3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
   4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

1.09 RESPONSIBILITIES

A. The Electrical Contractor shall be responsible for providing all equipment, backboards, equipment racks and cabinets, mounting hardware, associated equipment within each equipment rack and cabinet and associated support, splices, terminating hardware, etc. as necessary to provide a functional equipment mounting system for the communications equipment.

B. The Electrical Contractor shall be responsible for providing all backboard, back-boxes, pull-boxes, junction boxes, conduit, and sleeves as indicated in the plans and specifications to support the low voltage systems

C. The Electrical Contractor shall be responsible for coordinating installation with general contractor and other trades on the job to insure pathways are not impeding other system installations.

D. The term Electrical Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives used in this specification document to produce the finished product as described here-in.

E. The Low Voltage Contractor for this project shall be contracted by the General Contractor/ Electrical Contractor.

PART 2 - PRODUCTS

2.01 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

2.02 POWER STRIPS

A. Acceptable Manufacturers:
   1. APC

B. Power Strips: Comply with UL 1363.
   1. Vertical offset mounting including required mounting hardware.
   2. Wall mounted equipment cabinets shall include an internally mounted power strip, including required mounting hardware.
   3. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
   4. LED indicator lights for power and protection status.
   5. LED indicator lights for reverse polarity and open outlet ground.
   6. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
   7. Rocker-type on-off switch, illuminated when in on position.

2.03 EQUIPMENT FRAMES

A. General
   1. Waterfall cable management shall be provided at the top of the rack for patch cords and for horizontal cables entering the rack channels from cable tray for protection and to maintain proper bend radius and cable support.
   2. Horizontal wire management shall be mounted below each patch panel and/or piece of equipment on the rack. The horizontal wire management shall be a minimum of one rack-units (RU), refer to project plans for exact size and description.
   3. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack as required. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Rack shall be black in color to match the patch panels and cable management.
   4. All equipment racks shall be fully enclosed and lockable
   5. Floor mounted equipment racks shall be Middle Atlantic CAT#VRK-44-36H

B. Wall Mounted Equipment Rack
   1. Approved Manufacturer
      a. Chatsworth CPI
   2. Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA/EIA-568-B.
   3. Provide standard EIA 19” channel front and rear.
   4. Universal 5/8”-5/8”-1/2” hole pattern.

5. Shall be UL listed.

2.04 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:
   1. Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
   2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
   3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with ANSI-J-STD-607-A.

2.05 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

A. Contact owner and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by owner.

B. Install underground pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.

C. Install underground entrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical Systems."

3.02 INSTALLATION

A. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

B. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.03 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping. "Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.04 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

3.05 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems." Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section.

Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration including optional identification requirements of this standard.

C. Labels shall be preprinted or computer-printed type.

END OF SECTION

SECTION 271300

COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED WORK AND REQUIREMENTS

A. Section 270500 – Common Work Results for Communications

B. Section 270526 – Grounding and Bonding for Communications Systems

C. Section 270528 – Pathways for Communications Systems

D. Section 271100 – Communications Equipment Room Fittings

E. Section 271500 – Communications Horizontal Cabling

F. Section 281300 – Electronic Access Control Systems

1.03 GENERAL

A. Use of a manufacturer's name and model or catalog number is for the purpose of establishing standard of quality, general configuration, and operating characteristics desired only. This specification is intended to be a minimum standard for function, operation and performance. Equipment catalog numbers are listed to establish this minimum.

B. Section Includes:
   1. UTP cable
   2. Fiber Optic Cable
   3. Cable connecting hardware, patch panels, and cross-connects.
   4. Cabling identification products.

1.04 SUMMARY OF WORK

A. Furnish and install complete with all accessories a communication backbone cable system. The backbone cable shall serve as a vehicle for transport of data, video and voice telephony signals throughout the network between designated demarcation points and other locations as indicated on the contract drawings and described herein.

B. The Low Voltage Contractor shall maintain a current copy of the design drawings, specifications, installation schedule, equipment submittals and shop drawings at the job site at all times. These documents shall be made available to the Owner/Engineer at their request.

C. Throughout the project, the Low Voltage Contractor shall provide levels of manpower necessary to meet all construction schedules.

D. Cabling utilized for data and voice communications shall terminate in either wall mounted termination blocks, cabinets, or panels, in vertical free standing equipment racks, and/or enclosed equipment racks located at the Telecommunications Equipment Room (TER), the Main Cross-connect (MC), the Intermediate cross-connect (IC), and/or the Telecommunications Room (TR) location(s). All connectivity, wiring, terminations and patch bays between these designated demarcation points on the plans shall be considered part of the contract

E. The system shall utilize a network of fiber optic, and unshielded twisted pair, riser and tie cables. Cables and terminations shall be provided and located as shown and in the quantities indicated on the drawings.

1. Fiber cables shall terminate on fiber patch panels and/or modular patch panels located at demarcation and termination points shown on the drawings.
2. All cables and terminations shall be identified and labeled per owner specifications at all locations.
3. All cables shall terminate in an alpha-numeric sequence at all termination locations.

F. All copper cable terminations shall comply with, and be tested to ANSI/TIA/EIA 568-B standards.

G. Available and unused pairs between the ER (MDF) and TR (s) (IDF) shall be terminated, tested and shall be identified as spare at each location..

1.05 REFERENCES

A. ANSI/TIA/EIA 568-B.1 - Commercial Building Telecommunications Wiring Standards, General requirements.

B. ANSI/TIA/EIA 568-B.2 - Commercial Building Telecommunications Wiring Standards, Balanced Twisted Pair Cabling Components.

C. ANSI/TIA/EIA 568-B.3 - Commercial Building Telecommunications Wiring Standards, Optical Fiber Cabling Components standards.

D. ANSI/TIA/EIA-568-B.3-1 - Additional Transmission Performance Specifications for 50/125µm Optical Fiber Cables.

E. ANSI/TIA/EIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.

F. ANSI/TIA/EIA 606-A – Administration Standards for Commercial Telecommunications Infrastructures.

G. International Standards Organization/International Electrotechnical Commission (ISO/IEC) 11801.

H. Underwriters Laboratories (UL®) Cable Certification and Follow up Program.

I. National Electrical Manufacturers Association (NEMA).

J. American Society for Testing Materials (ASTM).

K. National Electric Code (NEC®), 1999

L. Institute of Electrical and Electronic Engineers (IEEE).

M. UL Testing Bulletin.

N. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps.

O. BICSI – TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM) most recent version.

1.06 RESPONSIBILITY

A. The term Low voltage Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.

B. The Low Voltage Contractor for this project shall be contracted by the General Contractor/Electrical Contractor.

1.07 DEFINITIONS

A. Backbone cabling System: A Communication Backbone Cabling System is defined as all required equipment and cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, UTP and fiber optic cable installed and configured to provide computer data and voice connectivity between entrance facilities, equipment rooms, main distribution

frames, and intermediate distribution frames with the network file server or voice network/switch designated as the service point of the local area network.

B. Riser Backbone: The Riser Backbone subsystem links the main cross connect (MC) and telecommunications rooms (TR). It consists of the backbone transmission media between these locations and the associated connecting hardware terminating this media. It is normally installed in a star topology, with first-level backbone cables beginning at the main cross connect. If needed, second-level backbone cables begin at intermediate cross connects.

C. Campus Backbone: A Campus Backbone is used when a distribution system encompasses more than one building. The components and cables that provide the link between buildings constitute the Campus Backbone. This subsystem includes the backbone transmission media, associated connecting hardware terminating this media, and electrical protection devices to mitigate harmful voltages when the media is exposed to lightning and/or power surges. It is normally first-level backbone cables beginning at the main cross connect in the equipment room of the hub building and extending to the intermediate cross connect in the equipment room of a satellite building.

D. Equipment Subsystem: The Equipment Subsystem consists of shared (common) electronic communications equipment in the equipment room, main cross connect or telecommunications closet and the transmission media required to terminate this equipment on the distribution hardware.

E. The Administration Subsystem: The Administration Subsystem links all of the subsystems together. It consists of labeling hardware for providing circuit identification and patch cords or jumper wire used for creating circuit connections at the cross connects.

F. BICSI: Building Industry Consulting Service International.

G. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

H. EMI: Electromagnetic interference.

I. IDC: Insulation displacement connector.

J. LAN: Local area network.

K. RCDD: Registered Communications Distribution Designer.

L. UTP: Unshielded twisted pair.

1.08 BIDDING

A. At the time of bid, in addition to a complete bid including all pricing information, provide the following:
   1. A detailed description of any and all additions, deletions or exceptions taken to the bid documents. Include the reasons why changes are being proposed.
   2. Detailed breakout of all requested alternate pricing.
   3. A price to furnish and install each individual media type and system component under this proposed work.
   4. Manufacturer’s original equipment cut sheets for each product for use on this project.
   5. Add/Delete pricing per foot for each type of backbone cabling used on this project as identified in the project drawings.

1.09 SUBMITTALS

A. Product Data:
   1. Provide manufacturer’s catalog information showing dimensions, colors, and configurations.
   2. Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:

a. All optical fiber, copper cable and coax cable
b. All connectors and required tooling.
c. All termination system components for each cable type.
d. All building entrance protection surge suppression system components.

3. For UTP copper cable, provide manufactures technical data sheet that includes the following installation data for each type used:
   a. Mutual Capacitance
   b. Impedance
   c. DC Resistance
   d. Attenuation (Insertion Loss)
   e. Return Loss
   f. Worst Pair-to-Pair Near End Crosstalk (NEXT)
   g. Power Sum Near End Crosstalk (PSNEXT)
   h. ELFEXT (ACRF)
   i. Power Sum ELFEXT (PSACRF)
4. For optical fiber cable, provide manufactures technical data sheet that includes the following installation data for each type used:
   a. Maximum Attenuation
   b. Minimum LED Bandwidth
   c. Minimum Effective Modal Bandwidth
5. All submitted product sheets containing more than one product or multiple product options shall have the submitted product clearly identified for review with all options highlight as intended for review.

B. Shop Drawings:
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts including floor plans indicating telecommunication spaces (EF/ER/TR), primary cable pathways and telecommunication outlets (with circuit ID's).
3. Wiring diagrams to show typical wiring schematics for patch panels and wiring blocks.
4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Pre-Qualification Certificate: Low Voltage Contractor shall submit the following documents with project proposal:
1. Submit proof from manufacturer of the Low Voltage Contractor's good standing in the cabling manufacturer's qualification program.
2. Submit training certificates for design, engineering and installation of the proposed products awarded to the Low Voltage Contractor's assigned project manager and installers. All installers working on this project shall be certified in the manufacturer's certified installers program.

D. Test Equipment
1. Provide a complete list of the test equipment to be utilized, including part numbers.
2. Provide certificates for the latest manufacturer calibration for each piece of test equipment to be utilized.

E. Warranty Documentation
1. Complete documentation regarding the manufacturer's Extended Product Warranty and Application Assurance Program shall be submitted as part of the proposal. This shall include, but is not limited to: a sample of the warranty that will be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues and guaranteed performance information.
2. A systems application assurance manual documenting the vendor supported applications and application guidelines shall be provided as part of the submittals.

1.10 CLOSEOUT SUBMITTALS

A. As-Built Documentation: As specified in Section 3.06 /I.

B. Test Results: Test results shall be submitted in both PDF form and in the native electronic file format of the test equipment.
   1. Test equipment firmware and software versions.
   2. Test equipment proof of calibration documentation.

1.11 QUALIFICATIONS

A. Low Voltage Contractor
   1. The Low Voltage Contractor selected to provide the installation of this system shall be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein.
   2. The Low Voltage Contractor shall utilize the authorized manufacturer components and distribution channels in provisioning this Project.
   3. The Low Voltage Contractor shall have a minimum of five (5) years of recent experience on structured cabling systems of similar type and size.
   4. The Low Voltage Contractor and design firm shall be in compliance with all federal, state and local statutes regarding qualifications of firms.
   5. The Low Voltage Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
   6. The Low Voltage Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and metallic premise distribution systems.
   7. The Low Voltage Contractor shall have personnel who are adequately trained in the usage of such tools and equipment.
   8. The Low Voltage Contractor shall submit a resume of qualification with the vendor's proposal indicating the following:
      a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
      b. A list of test equipment proposed for use in verifying the installed integrity of metallic and fiber optic cable systems on this project.
      c. A technical resume of experience for the Low Voltage Contractor's Project Manager and on-site installation supervisor who will be assigned to this project.
      d. A list of technical product training attended by the Low Voltage Contractor personnel that will install the system.
      e. Any Sub-Contractor, who will assist the Low Voltage Contractor in performance of this work, shall have the same required training and certification as the Low Voltage Contractor.

1.12 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.13 CABLING BASIC REQUIREMENTS

A. Cable Pathway: Extension of all data and voice backbone cables shall be within raceway, conduit, cable tray or other designated cable delivery system.

B. Hardware: Required hardware includes, but is not limited to, termination blocks, fastening devices, connectors and all required accessories to comply with this specification.

1.14 GROUNDING AND BONDING

A. All grounding and bonding shall meet the National Electrical Code (NEC®) as well as local codes which specify additional grounding and/or bonding requirements.

B. Bonding and Grounding
   1. Communication bonding and grounding shall be in accordance with the NEC® and NFPA. Backbone cables shall be grounded in compliance with ANSI/NFPA 70 and local requirements and practices. Backbone equipment includes cross connect frames, patch panels and racks. When required by local code, provide a Telecommunications Bonding Backbone utilizing a #6-AWG or larger bonding conductor that provides direct bonding between equipment rooms and telecommunications closets. Refer to BICSI TDMM 10th edition, chapter 10 table 10.1 for bonding conductor sizing. This is part of the grounding and bonding infrastructure (part of the telecommunications pathways and spaces in the building structure), and is independent of equipment or cable.
   2. Comply with ANSI-J-STD-607-A.

1.15 SPECIAL REQUIREMENTS FOR CABLE ROUTING AND INSTALLATION

A. Cabling
   1. All communications cabling used throughout this project shall comply with the requirements as outlined in the National Electric Code (NEC®) Articles 725, 760, 770, and 800 and the appropriate local codes.
   2. All copper cabling shall bear CM/CMR (Riser Rated) and/or appropriate markings for the environment in which they are installed.
   3. All fiber optic cabling shall bear OFNR (Riser Rated) and/or appropriate markings for the environment in which they are installed.
   4. Sealing of openings around the exterior of the sleeves or openings between floors, through rated fire and smoke walls, existing and created by others shall be the responsibility of others. Sealing of openings between floors used by system vendor for cable pass through, sealing of space internal to the sleeves used for cable pass through and sealing of openings around the exterior of sleeves installed by System Vendor shall be the responsibility of the System Vendor.
   5. Sealing material and application of this material shall be accomplished in such a manner which is acceptable to the local fire and building authorities having jurisdiction over this work.
   6. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the System Vendor.
   7. Any openings created by or for the System Vendor and left unused shall also be sealed as part of this work.

B. Low Voltage Contractor Responsibility: The Low Voltage Contractor shall be responsible for damage to any surfaces or work disrupted as a result of his work. Repair of surfaces, including painting, shall be included as necessary.

1.16 DELIVERY, STORAGE, AND HANDLING

A. Test all optical fiber cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set
   2. Test optical fiber cable while on reels.
   3. Visually inspect all cable upon delivery for damage during transport.
   4. Store cables in dry areas that are free of potential pre-installation damage.

B. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.17 WORK EXTERNAL TO THE BUILDING

A. Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification and the applicable drawings.

PART 2 - PRODUCTS

2.01 EQUIVALENT PRODUCTS

A. Equivalent product(s) may be considered for substitution for those products specified, however, the equivalent product(s) must be approved and show demonstrated and documented equivalence to the product(s) specified.

B. Documentation shall include, but is not limited to: product samples, data sheets, and actual test data.

C. The request for product substitution, and supporting documentation, must be submitted, in writing five (5) days prior to submitting the bid.

D. Written approval for product substitution must be submitted with the bid.

2.02 UTP COPPER CABLE

A. Approved Manufacturers
   1. Superior-Essex
   2. CommScope (Final approval required by SWSD)

B. UTP CMR/CMP Riser
   1. The CMR rated riser cable shall consist of solid copper conductors insulated with and covered by a polyolefin or PVC (polyvinyl chloride) flame retardant jacket.
   2. The CMP rated riser cable shall consist of solid copper conductor, 24 AWG, covered by a low smoke FR-PVC jacket.
   3. The sheath shall have improved frictional properties allowing it to be pulled through conduit without the use of lubricants.
   4. The cable shall be available in pair counts as indicated on drawings.

C. UTP Outside Plant Copper Cables (PE89, PE39, PE22 type)
   1. All voice grade wire and cable placed in the outside environment shall be solid, twisted pair, and multi-conductor.
   2. Buried and underground cable shall have a corrugated, copolymer coated, 8-mil aluminum tape with overlap applied longitudinally.
   3. The core assembly shall be filled with a gel compound completely filling the interstices between the pairs and under the core wrap.
   4. The cable shall be available in pair counts as indicated on drawings.

D. Description: Outside Plant 100-ohm, 24 AWG multi-pair UTP cable, formed into 25-pair binder groups covered with a black thermoplastic jacket and overall metallic shield.
   1. Comply with ICEA S-90-661 for mechanical properties.
   2. Comply with TIA/EIA-568-C.1 for performance specifications.
   3. Comply with TIA/EIA-568-C.2, Category 5e.
   4. Cables larger than 25 pairs shall be constructed with pairs separated into color-coded 25-pair sub-units per ICEA publication S-80-576. Cables up to 600 pairs shall be constructed with 25-pair binder groups combined into super units. Each super unit shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow and violet. Binder color code integrity shall be maintained at all cable splice locations.
   5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
      a. Communications, Outside Plant Rated: Type CMX
   6. All copper cabling shall bear the cable's rating and/or appropriate markings for the environment in which they are installed printed directly on the cable jacket.
   7. ISO 9001 Certified Manufacturer

2.03 66- WIRING BLOCK

A. Approved Manufacturers
   1. Hubbell (89D bracket with 66M1-50 block)

B. The wiring block shall facilitate cross connection and interconnection using either cross connect wire (voice only) or the appropriate category patch cords.

C. The wiring block shall have plaster board, “blue board” or equivalent backing for all punch-block backing.

D. The wiring blocks shall be fire retardant, molded plastic consisting of horizontal index strips for terminating 25 pairs of conductors each. The index strips shall be marked with five colors on the high teeth, separating the tip and ring of each pair, to establish pair location.

E. A series of fanning strips shall be located on each side of the block for dressing the cable pairs terminated on the adjacent index strips.

F. The wiring block shall accommodate 19- through 26-AWG conductors and shall be able to mount directly on wall surfaces with or without backboards or on a 19” free-standing frame.

G. Clear label holders with the appropriate colored inserts shall be provided with the wiring blocks. The insert labels shall contain vertical lines spaced on the basis of circuit size (3-, 4-, or 5-pair) and shall not interfere with running, tracing or removing jumper wire/patch cords.

H. The wiring blocks shall be available in 100 and 300 pair sizes and shall be available with or without legs depending on the mounting.

I. The wiring block shall be able to accommodate over 500 repeated insertions without incurring permanent deformation and it shall pass the reliability test of no more than one contact failure in 10000 connections.

J. Jumper Trough
   1. Provide a horizontal trough for the routing of patch cords and/or cross connect wire.
   2. Provide a horizontal trough between each wiring block and top and bottom of each group of wiring blocks.
   3. Provide vertical cross-connect management with troughs integrated with the frame.

2.04 PRODUCT WARRANTY AND APPLICATION ASSURANCE

A. The Structured Cabling System (SCS) shall be provided with an Extended Product Warranty and Application Assurance Program guaranteeing performance and operation of the SCS (including optical fiber and copper cabling).

B. Extended Product Warranty
   1. The Extended Product Warranty covers product defects for all passive components of the SCS. Passive components are defined as those exhibiting no gain or contributing no energy. The manufacturer shall warrant, from the date a Registration Certificate is issued by the manufacturer to the end-user, the following:
   2. The passive products that comprise the registered SCS will be free from manufacturing defects in material or workmanship under normal and proper use.
   3. All SCS approved passive cabling products that comprise the registered SCS solution exceed the specification of ANSI/TIA-568-C.1, ANSI/TIA-568-C.2 and ANSI/TIA-568-C.3 standards and will conform to the guaranteed minimum performance specifications published within the manufacturer’s associated product data sheet and warranty platform documentation in effect at the time the Registration Certificate is issued for the duration of the extended warranty period.

C. Term of Warranty
   1. The Extended Product and Application Assurance Warranty shall span minimum 20 years from the date of issuance of the Registration Certificate or completion of installation, whichever is later.
   2. The warranty shall be for the benefit of the person or entity to which the manufacturer's SCS Registration Certificate is issued and any successor in interest to the site in which such System was originally installed by the manufacturer or an Authorized manufacturer's Reseller.
   3. If the manufacturer repairs the product, the repair shall utilize only new replacement parts. Replacement of existing parts shall be with new parts of the same design meeting or exceeding the performance of the replaced parts. Any such repair or replacement shall include a warranty for either 90 days or the remainder of the original warranty period, whichever is longer.

2.05 OPTICAL FIBER CABLING

A. General
   1. The cable must meet the requirements of the National Electric Code (NEC) Section 770.
   2. Plenum Applications - Applicable Flame Test: UL 910 (NFPA 262-1994)

B. Optical Fiber Characteristics
   1. Acceptable Manufacturers
      a. Corning
   2. All fibers must be useable and meet the required specifications. All optical glass shall be manufactured by Corning Optical Fiber Products.
   3. All fiber cables must be flame retardant and meet UL-1666 OFNR specification
   4. All optical fibers shall be sufficiently free of surface imperfections and occlusions to meet the optical, mechanical, and environmental requirements of this specification
   5. A silica core surrounded by a concentric silica glass cladding shall comprise each optical fiber. The fiber shall be a matched clad design manufactured by the outside vapor deposition process (OVD).
   6. Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m2). The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.
   7. The attenuation specification shall be a maximum value for each cabled fiber at 23 $\pm$ 5°C on the original shipping reel.
   8. Single-mode and Multi-mode optical fiber cable shall be available in standard strand counts as indicated on drawings.
   9. Inside plant cable (including indoor/outdoor rated cabling) shall be reinforced with Aramid yarn for superior strength.
   10. All loose-tube constructed optical fiber cable shall meet the following requirements:
      a. The cable shall be constructed with industry standard 3mm buffer tubes, stranded around a central strength member.
      b. The buffer tubes shall be compatible with standard hardware, cable routing and fan-out kits.
      c. The cable core shall be water blocked without the use of flooding compounds.
   11. Packing and Shipping
      a. The cable shall be packaged in cartons and/ or wound on spools or reels. Each package shall contain only one continuous length of cable with sufficient length for entire run without splicing. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.
      b. Tests tails shall be at least 2 meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation. Tails shall be permanently marked with an identification number that it can be used by the manufacturer to trace the manufacturing history of the cable and the fiber.

C. Indoor/ Outdoor Riser-Rated Loose Buffered Optical Fiber Cable.
   1. Fiber bundles wrapped in water swellable yarns within loose tubes.
   2. Water swellable yarns routed between and surrounding the separate tubes
   3. Color-coded fibers and buffer tubes.
   4. Ripcord
   5. Dielectric strength members all surrounded in a UV-resistant/flame-retardant outer jacket.
   6. All-dielectric construction.
   7. Flexible buffer tubes.
   8. UL-listed OFNR (UL1600) and CSA-listed FT-4.

D. Optical Fiber Outside Plant (OSP) Cable
   1. This cable is designed to connect equipment or facilities that are separated by an outdoor type environment.
   2. The cable shall be armored with a corrugated polymer coated steel tape constructed with industry standard 3mm buffer tubes, stranded around a central strength member.
   3. It shall be suitable for underground, aerial, direct buried, tunnel, or tray installations.
   4. Outside plant cabling shall be of loose tube construction.
   5. The cable shall be constructed with industry standard 3mm buffer tubes, stranded around a central strength member.
   6. The buffer tubes shall be compatible with standard hardware, cable routing and fan-out kits.
   7. The cable core shall be water blocked without the use of flooding compounds.
   8. The cable shall be designed for point-to-point applications as well as midspan access, provide a high-level of protection for fiber installed in the outside plant environment.

E. Pre-Terminated Optical Fiber Cable Assemblies
   1. Pre-terminated optical fiber cable assemblies include trunk cables, equipment cords, cross-connect cords and ruggedized fan-outs.
   2. Cable Construction
      a. All cables shall be constructed with one or more subunits, each with 12 fibers surrounded by a jacket containing aramid yarn strength members.
      b. All cable used within the system shall be generally round in construction with the exception of 24-fiber, which shall be side-by-side 12-fiber subunits with a secondary jacket.
      c. Cables may not contain any splices of any kind.
      d. The lengths of the breakout sections shall be staggered for easy routing and handling of the cable assembly.
      e. Pulling socks shall be available that attach to one end of the cable to protect the connector terminations during installation.
      f. The cable shall include a ripcord beneath the outer jacket to allow for customization of the 12-fiber subunit breakout length after installation.
      g. All cables shall be available in Zero/Low Water Peak Single-Mode or 62.5/125 Multimode fiber, with or without aluminum interlocking armor.

2.06 MULTI-MODE OPTICAL FIBER

A. Standard 62.5-Micron Multi-Mode Optical Fiber Cable
   1. Multimode fiber shall meet the following standards
      a. EIA/TIA-492AAAA-A-1997, “Detail Specification for 50-μm Core Diameter/125-μm Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers."
      b. ISO/IEC 11801 type OM1 fiber
   2. The core diameter shall be 62.5 ± 3.0 μm. The core non-circularity shall be ≤ 5.0%.
   3. The cladding diameter shall be 125.0± 2.0 μm. The cladding non-circularity shall be ≤1.0%.
   4. The core-to-cladding concentricity shall be ≤1.5 μm.
   5. The coating outside diameter shall be 245 ± 5 μm.
   6. The colored fiber nominal diameter shall be 253 – 259 μm.

7. The optical fiber refractive index profile shall be graded. The numerical aperture shall be 0.275 ± 0.015.
8. The maximum cabled fiber attenuation shall be ≤ 3.0 dB/km at 850 nm and ≤0.7 dB/km at 1300 nm.
9. The point of discontinuity shall be ≤ 0.2 dB at 850 nm and ≤0.2 dB at 1300 nm.
10. The macro bend attenuation shall be ≤ 0.5 dB at 850 nm and ≤0.5 dB at 1300 nm at 100 turns around a mandrel with an OD of 75 ± 2 mm.
11. The cabled effective modal bandwidth shall be ≥220 MHz/km at 850 nm.
12. The cabled optical fiber shall support industry-standard IEEE 802.3 10GBASE-S (10 Gigabit Ethernet at 850 nm) physical layer specifications.
13. The optical fiber shall support laser-based Gigabit Ethernet (GbE) operation in the 1000BASE-SX operating window (850 nm) at 300 meters, and in the 1000BASE-LX operating window (1300 nm) at 550 meters.
14. The OFL bandwidth shall be ≥200 MHz/km at 850 nm and ≥500 MHz/km at 1300 nm.
15. The optical fiber cable construction shall be loose tube.

2.07 SINGLE-MODE OPTICAL FIBER

A. Single-Mode Optical Fiber in Tight Buffer Cables
1. The single-mode fiber shall meet EIA/TIA-492CAAB, “Detail Specification for Class IV a Dispersion-Un-shifted Single-Mode Optical Fibers with Low Water Peak” and ITU-T G.652.C, “Characteristics of Single-Mode Optical Fiber Cable.”
2. The cladding diameter shall be 125.0 ± 0.7 μm. The cladding non-circularity shall be ≤0.7%
3. The core-to-cladding concentricity shall be ≤0.5 μm.
4. The coating outside diameter shall be 245 ± 5 μm.
5. The colored fiber nominal diameter shall be 253 – 259 μm.
6. The mode field diameter at 1550 nm shall be 10.4 ± 0.5 μm.
7. The fiber curl radius of curvature shall be ≥ 4.0 m.
8. The optical fiber refractive index profile shall be graded. The numerical aperture shall be 0.200 ± 0.015. ≥4.0 m.
9. The maximum cabled fiber attenuation shall be ≤ 1.0 dB/km at 1310 nm, ≤ 1.0 dB/km at 1383 ± 3 nm and ≤ 0.75 dB/km at 1550 nm.
10. The point of discontinuity shall be ≤ 0.5 dB at 1310 nm and ≤ 0.5 dB at 1550 nm.
11. The macro bend attenuation shall be ≤ 0.05 dB at 1550 nm at 1 turn around a mandrel with an OD of 32 ± 2 mm; ≤ 0.05 dB at 1310 nm and ≤ 0.10 dB at 1550 nm at 100 turns around a mandrel with an OD of 50 ± 2 mm; and ≤ 0.05 dB at 1550 nm and ≤ 0.05 dB at 1625 nm at 100 turns around a mandrel with an OD of 60 ± 2 mm.
12. The cable cutoff wavelength (λ_{ccf}) shall be ≤ 1260 nm.
13. The zero dispersion wavelength (λ_0) shall be $1302 \leq \lambda_0 \leq 1322$ nm.
14. The zero dispersion slope (S_0) shall be ≤ 0.089 ps/(nm^2*km).
15. The total dispersion shall be ≤ 3.5 ps/(nm^2*km) at 1285-1330 nm, ≤ 17.5 ps/(nm^2*km) at 1550 nm and ≤ 21.5 ps/(nm^2*km) at 1625 nm.
16. The cabled polarized mode dispersion shall be ≤ 0.2 (ps/√km).
17. The optical fiber shall support IEEE 802.3 GbE - 1300 nm laser distances at 5000 m.
18. The water peak attenuation at 1383 ± 3 nm at ≤ 1.0 dB/km.

B. Single-Mode Optical Fiber in Bend Insensitive Tight Buffer Cables
1. The single-mode Low Water Peak fiber utilized in the optical fiber cable shall meet EIA/TIA-492CAAB, “Detail Specification for Class IV a Dispersion-Un-shifted Single-Mode Optical Fibers with Low Water Peak” and ITU-T G.652.D, “Characteristics of Single-Mode Optical Fiber Cable,” and ITU-T G.657, Table A, “Characteristics of a Bending Loss Insensitive Single Mode Optical Fiber for Access Networks.”
2. The cladding diameter shall be 125.0 ± 0.7 μm. The cladding non-circularity shall be ≤0.7%
3. The core-to-cladding concentricity shall be ≤0.5 μm.

4. The coating outside diameter shall be 245 ± 5 μm.
5. The colored fiber nominal diameter shall be 253 – 259 μm.
6. The mode field diameter at 1550 nm shall be 9.8 ± 0.5 μm.
7. The fiber curl radius of curvature shall be ≥ 4.0 m.
8. The maximum cabled fiber attenuation shall be ≤ 1.0 dB/km at 1310 nm, ≤ 1.0 dB/km at 1383 ± 3 nm and ≤ 0.75 dB/km at 1550 nm.
9. The point of discontinuity shall be ≤ 0.5 dB at 1310 nm and ≤ 0.5 dB at 1550 nm.
10. The macrobend attenuation shall be ≤ 0.05 dB at 1550 nm at 1 turn around a mandrel with an OD of 20 ± 2 mm; ≤ 0.05 dB at 1550 nm at 10 turns around a mandrel with an OD of 30 ± 2 mm; and ≤ 0.01 dB at 1625 nm at 100 turns around a mandrel with an OD of 60 ± 2 mm.
11. The cable cutoff wavelength (λ_{ccf}) shall be ≤ 1260 nm.
12. The zero dispersion wavelength (λ_0) shall be $1302 \leq \lambda_0 \leq 1322$ nm.
13. The zero dispersion slope (S_0) shall be ≤ 0.089 ps/(nm^2*km).
14. The total dispersion shall be ≤ 3.5 ps/(nm^2*km) at 1285-1330 nm, ≤ 18.105 ps/(nm^2*km) at 1550 nm and ≤ 22.0 ps/(nm^2*km) at 1625 nm.
15. The cabled polarized mode dispersion shall be ≤ 0.2 (ps/√km).
16. The optical fiber shall support IEEE 802.3 GbE - 1300 nm laser distances at 5000 m.
17. The water peak attenuation at 1383 ± 3 nm at ≤ 1.0 dB/km.

C. Single-Mode Optical Fiber in Loose Tube and Ribbon Cables
1. The single-mode fiber shall meet EIA/TIA-492CAAA, “Detail Specification for Class Iva Dispersion-Un-shifted Single-Mode Optical Fibers,” and ITU recommendation G.652.D, “Characteristics of a single-mode optical fiber cable”
2. The cladding diameter shall be 125.0 ± 0.7 μm.
3. The core-to-cladding concentricity shall be ≤0.5 μm.
4. The cladding non-circularity shall be ≤0.7%
5. The mode field diameter shall be 9.2 ± 0.4 μm at 1330 nm, and 10.4 ± 0.5 μm at 1550 nm.
6. The coating outside diameter shall be 245 ± 5 μm.
7. The colored fiber nominal diameter shall be 253 – 259 μm.
8. The fiber curl radius of curvature shall be ≥ 4.0 m.
9. The cabled fiber attenuation shall be ≤ 0.4 dB/km at 1310 nm, and ≤ 0.3 dB/km at 1550 nm.
10. The point of discontinuity shall be ≤ 0.1 dB at 1310 nm and ≤ 0.1 dB at 1550 nm.
11. The macro bend attenuation shall be ≤ 0.05 dB at 1550 nm at 1 turn around a mandrel with an OD of 32 ± 2 mm; ≤ 0.05 dB at 1310 nm at 100 turns around a mandrel with an OD of 50 ± 2 mm; ≤ 0.10 dB at 1550 nm at 100 turns around a mandrel with an OD of 50 ± 2 mm; ≤ 0.05 dB at 1550 nm at 100 turns around a mandrel with an OD of 60 ± 2 mm; and ≤ 0.05 dB at 1625 nm at 100 turns around a mandrel with an OD of 60 ± 2 mm.
12. The cable cutoff wavelength (λ_{ccf}) shall be ≤ 1260 nm.
13. The zero dispersion wavelength (λ_0) shall be $1302 \leq \lambda_0 \leq 1322$ nm.
14. The zero dispersion slope (S_0) shall be ≤ 0.089 ps/(nm^2*km).
15. The total dispersion shall be ≤ 3.5 ps/(nm^2*km) at 1285-1330 nm, ≤ 17.5 ps/(nm^2*km) at 1550 nm and ≤ 21.5 ps/(nm^2*km) at 1625 nm.
16. The cabled polarized mode dispersion shall be ≤ 0.2 (ps/√km).
17. The optical fiber shall support IEEE 802.3 GbE - 1300 nm laser distances at up to 5000 m.
18. The water peak attenuation at 1383 ± 3 nm at ≤ 0.4 dB/km.

2.08 OPTICAL FIBER CONNECTORS

A. General Connector Requirements
1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of ANSI/TIA-604 and appropriate sub sections. Comply with ANSI/TIA-568-C.3.
2. Multi-Mode and Single-mode fiber optic connectors shall be factory or field installed.

3. Multi-mode fiber optic connectors shall be quick-connect anaerobic or heat cure terminated connectors.
4. Single-Mode fiber optic connectors shall be factory-polished fusion duplex LC style connectors.
5. Multi-Mode fiber optic connectors shall duplex ST style connectors.
6. Fiber connectors shall have < 0.2 dB change after 500 re-matings.
7. The connector operating temperature shall be -40 to 167°F .
8. Connectors shall have a temperature stability Insertion Loss Change of <0.3 dB.

B. ST Optical Fiber Connectors
1. The connector shall be available for multimode fiber optic cables.
2. The connector shall be a bayonet-type fiber optic connector with a pull-proof enhanced hardware design.
3. The connector shall have a domed zirconia ferrule
4. The connector shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.
5. The connector shall accept 125-micron outside diameter multimode fiber.
6. ST type connectors shall have an average loss of 0.3dB per mated pair.

C. LC Optical Fiber Connectors
1. The fiber optic connector shall be one half the size (double density) of conventional ST and SC connectors.
2. The connector shall utilize ceramic tips.
3. The connector shall have an insertion release mechanism similar to the RJ-45 intuitive push/pull-style housing.
4. The connector shall be pull-proof to prevent momentary disconnect from axial loads with a cable retention rating of 2 lbs.
5. The connector possess an anti-snag latch which facilitates routing of patch cords
6. The connector shall be factory-polished fusion connectors.
7. The connector shall be polarized.
8. The connector shall be Bellcore, TIA/EIA and IEC compliant
9. LC type connectors shall have an average loss of 0.1dB for multi-mode cabling and 0.1dB (tuned)/ 0.15dB (untuned) for single mode cabling per mated pair. Connectors shall have a maximum return loss of -20 db for multi-mode cabling and -40 db for single mode cabling.

2.09 OPTICAL FIBER HOUSINGS

A. All optical fiber hardware shall be manufactured by the same manufacturer as the optical fiber cabling unless specified otherwise.

B. General Optical Fiber Housing Requirements
1. Optical fiber housing shall be available for cross-connection or inter-connecting purposes. The units shall provide for direct connectorization and pigtail splicing. All connector housings shall be meet the design requirements of ANSI/TIA/EIA-568 and the plastics flammability requirements of UL 94 V-0.
2. Each optical fiber housing shall accept a labeling scheme that complies with ANSI/TIA-606-A.
3. Each optical fiber housing shall include clamshell-type clamping mechanisms to provide cable strain relief. Each cable clamp shall accept one cable with an OD of 9.5 – 28.6 mm. Each cable clamp shall also handle multiple small fiber count cables when used with the multiple cables insert; these clamps shall have a capacity of five cables with an OD of ≤ 10.2 mm. Cable clamps shall be provided as required be the panel/ module loading of the connector housing.
4. Optical fiber housings shall be manufactured using 16 gauge aluminum or equivalent for structural integrity. Housings shall be finished with a wrinkled black powder coat for durability.

C. Connector Housings

1. Corning CCHSeries
2. Connector housings shall be mountable in an EIA-310 compatible 19” rack. Housing shall be a minimum of 1RU and be available in 2RU, 3RU and 4RU heights. Connector housing shall not exceed a depth of 12”.
3. Connector housings shall be modular in nature with separate splicing, jumper management and combination connector/ splicing housings available.
4. Connector housings shall be available in 2, 4, 6, 8, and 12 connector panel configurations.
5. The connector housing shall include jumper/ patch cord routing guides to allow a transition and segregation point for cords exiting the front and back of the housing.
6. Feeder cable entries shall have a grommet installed to minimize dust/ water intrusion.
7. Connector housings doors shall meet the following requirements:
   a. Shall have removable hinged front and rear doors.
   b. The front and rear doors shall be manufactured from tinted polycarbonate with slide latches.
   c. The front and rear doors shall be lockable.
8. Connector housings shall include provisions for mounting fiber fan-out devices and factory installed cable stubs for multiple cable and connector types.

2.10 CONNECTOR PANELS AND MODULES

A. Connector Panels
1. Connector panels shall be manufactured by the same manufacturer as the connector housing.
2. Connector panels shall utilize a single mounting footprint.
3. Connector panels shall be available in three, four, six, eight, and twelve connector adaptor configurations.
4. Connector panels shall be attached to the connector housing with a minimum of two push-pull style latches.
5. Connector panels shall be available in industry standard single fiber and small form factor multi-fiber adapters, including SC duplex, ST compatible, MTRJ and LC.
6. Unused spaces/opening in each housing shall be populated with connector panels matching the utilized connector panel configuration.
7. Connector panels shall be manufactured from 16 gauge cold rolled steel or injection molded polycarbonate.

B. Pre-Terminated Cassettes
1. Pre-terminated Cassettes shall utilize MPO-compatible 12-fiber male and female connectors plugs that are compatible with MPO adapters per IEC 61754-7 and ANSI/TIA 604.
2. The system consistent with the guidelines of ANSI/TIA-568-C.1.
3. The system shall utilize “aligned key” adapters for every MPO mated connection, per TIA 604-5, K=2.
4. Pre-terminated cassettes shall be available in optical fiber counts of 12 and 24.
5. Optical fiber trunk cabling shall terminate on the pre-terminated cassette utilizing the MPO type connector.
6. Optical fiber patching cabling terminations shall be available in ST and LC type connectors. ST and LC terminations shall be available in duplex configurations.
7. Pre-terminated cassettes shall be available in both single-mode and multi-mode configurations.
8. Cable splices of any kind shall not be permitted.
9. Pre-terminated cassettes shall be manufactured by the same manufacturer as the connector housing.
10. Pre-terminated cassettes shall utilize a single mounting footprint.
11. Pre-terminated cassettes shall be available in three, four, six, eight, and twelve connector adaptor configurations.

12. Pre-terminated cassettes shall be attached to the connector housing with a minimum of two push-pull style latches.
13. Pre-terminated cassettes shall be manufactured from 16 gauge cold rolled steel or injection molded polycarbonate.

C. Connector Modules
1. The connector module shall be a modular removable case containing optical fiber connector adapters and provisions for strain-relief, slack storage, and the furcation of fiber optic cables.
2. Connector modules shall be manufactured by the same manufacturer as the connector housing.
3. Connector modules shall consist of a panel incorporated into a protective case with a removable cover for access to the interior connectors and fibers.
4. Connector modules shall include a fiber retaining spool for managing slack fiber.
5. Connector modules shall utilize a single mounting footprint.
6. Connector modules shall be available in three, four, six, eight, and twelve connector adaptor configurations.
7. Connector modules shall be attached to the connector housing with a minimum of two push-pull style latches.
8. Connector panels shall be available in industry standard single fiber and small form factor multi-fiber adapters, including ST duplex and LC.
9. Connector modules shall be manufactured from 16 gauge cold rolled steel or injection molded polycarbonate.
10. Connector modules shall be available in the following configurations: adapter modules, pigtail modules, and pre-terminated system modules.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. Components of the backbone cabling system shall be installed in a neat, workmanlike manner.

B. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the system.

C. Identification markings and systems shall be uniform.

D. The Low Voltage Contractor shall be responsible for damage to any surfaces or work disrupted as a result of his work. Repair of and any charges resulting in the repair surfaces including painting shall be included as necessary.

3.02 GENERAL DESCRIPTION

A. The wiring system components shall comply with all product specifications contained in Section two.

B. All copper UTP backbone cabling shall be sized with 25 percent spare pairs for growth.

3.03 CAMPUS BACKBONE

A. Contractor shall supply and install the transmission media and terminating hardware to provide inter-building communications facility.

B. All campus backbone cabling shall be installed with a minimum of 10’-0” of slack at each point of termination.
1. All maintenance holes shall be “wrapped” such that a cable entering one wall shall not immediately exit the opposite/adjacent wall without being routed around the maintenance hole.

C. All cable routes to be approved by Engineer prior to installation.

D. Contractor shall supply outside plant multi-pair copper cable, outside plant optical fiber cable and electrical protection devices that will prevent electrical surges on the cable from entering buildings.

E. The cable distribution system shall be [aerial][direct buried][underground in conduit].

F. It shall be the responsibility of the Low voltage Contractor to secure any permits required for the construction of the outside plant.

3.04 EQUIPMENT ROOM

A. Terminations
   1. Low Voltage Contractor shall terminate all wires and fibers.

B. Electrical Protection
   1. Low Voltage Contractor shall supply lightning protectors and wires used to ground the equipment.
   2. The electrical protection devices supplied by the Low Voltage Contractor shall be in multi-pair form.
   3. For small pair count applications, Low Voltage Contractor shall supply electrical protection devices which consist of a mounting panel for a series of solid-state (or gas-tube) protector units and a wiring block. The wiring block shall be used for input and output cable terminations. Insertion of the protector units into the mounting block will complete the circuit.

3.05 ADMINISTRATION

A. The administration subsystem shall consist of wiring blocks and or patch panels for termination of copper cables or optical fibers. All wall field layouts to be as detailed on drawings or as approved by Engineer prior to installation.

B. Fields: Separate termination fields shall be created for voice and data applications if both are wall mounted.

C. Termination blocks: Termination blocks that require rotation after connection of horizontal/vertical wiring shall not be allowed.

D. Cross-connect wire, patch cords
   1. Low Voltage Contractor shall provide cross-connect wire, copper and fiber patch cords for cross-connection and inter-connection of termination blocks, patch panels, and fiber cabinets.
      a. Jumper type: The type of jumper cables shall depend on ANSI/EIA/TIA copper applications, or fiber application and the termination block used, i.e. a punch panel, a patch panel termination block and be part of the manufacturers total channel solution.

3.06 INSTALLATION

A. All installation shall be done in conformance with ANSI/EIA/TIA 568-B standards, federal and local standards and the cable manufacturers Installation guidelines.
   1. The Low Voltage Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Low Voltage Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation at no additional cost to the owner. This shall also apply to any and all damages sustained to the cables by the Low Voltage Contractor during the implementation.
   2. The Low Voltage Contractor shall make provisions so that all cabling is stored within a temperature controlled space to ensure that cabling is unspooled, manipulated, and worked with only when the cabling is within the manufacturer's installation temperature specifications and free of condensation.

B. Bonding and Grounding
   1. The Low Voltage Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework.
   2. All grounds shall consist of #6 AWG or larger (As required) copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground.
   3. Grounding must be in accordance with the NEC, NFPA and all local codes and practices.

C. Power Separation: The Low Voltage Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus. All SCS equipment and terminations must maintain proper separation from sources of EMI as per ANSI/TIA/EIA 562 B2 and 569-A and BICSI installation practices.

D. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
   4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
   5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
   6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

E. Miscellaneous Equipment: The Low Voltage Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire molding (MC & TR locations), miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the System.

F. Special Equipment and Tools: It shall be the responsibility of the Low Voltage Contractor to furnish any special installation equipment or tools necessary to properly complete the System. Tools shall include, but are not limited to:
   1. Tools for terminating cables,
   2. Testing and splicing equipment for copper/fiber cables,
   3. Communication devices,
   4. Jack stands for cable reels,
   5. Cable wenches.

G. Identification
   1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
      a. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

2. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
3. See Division 26 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.
4. Comply with requirements in Division 26 Section "Communications Horizontal Cabling" for cable and asset management software.
5. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
6. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
7. Cable and Wire Identification:
    a. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
    b. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
    c. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
    d. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
        1) Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
        2) Label each unit and field within distribution racks and frames.
    e. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
8. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following: Cables use flexible vinyl or polyester that flexes as cables are bent.

H. Cable Records: The Low Voltage Contractor shall maintain conductor polarity (tip and ring) identification at the main equipment room (switch room) and risers in accordance with industry practices.

I. As Built Documentation
1. Upon completion of the project, Low Voltage Contractor is to prepare "As Built" documentation showing actual site conditions and installation as constructed.
2. Provide copies of such documentation to the Owner as mentioned below.
    a. Upon completion of system installation, Low Voltage Contractor shall provide to Owner for its records the following:
        1) MC, TR and EF Diagrams which shall include:
            a) Cable routing
            b) Position of all components and
            c) Detailed layout of the wall field
            d) Labeling plan.
        2) Riser Distribution Plan
        3) Campus Distribution Plan

4) Fire Stop Penetrations and System ID

b. Documentation shall be in the following format:
   1) Four (4) copies of all diagrams and drawings matching the bid documents in size and format. One (1) copy of electronic plans, drawings and diagrams provided in both PDF format and the latest version of AutoDesk AutoCAD (or Revit if applicable) on CD/DVD Rom Disc, Flash Drive or digital file transfer via email or FTP.
   2) One (1) copy of electronic project records including cut sheets, test results (provided in both PDF format and the native tester file format) and cable connectivity schedules provided on CD/DVD Rom Disc, Flash Drive or digital file transfer via email or FTP.

J. Additional Records: In addition to the engineering diagrams, the following items shall be provided by the Low Voltage Contractor: Cable Records and Assignments detailing all connections to equipment, horizontal cable or riser cable for both copper and fiber cables.

3.07 PENETRATIONS OF WALLS, FLOORS AND CEILINGS

A. Prior consent: The Low Voltage Contractor shall make no penetration of floors, walls or ceiling without the prior consent from **exp** U.S. Services Inc.

B. Coordination: Coordinate the fire proofing manufacturer, product and specific sealing detail to be utilized on penetrations with other contractors to ensure that fire proofing seals are UL compliant.

C. Sealing penetrations – The area around the exterior of the sleeve shall be sealed by the contractor who installed the sleeve, the area internal to the sleeve shall be sealed by the Low Voltage Contractor who pulled or placed the cables.
   1. Where penetrations through acoustical walls or other walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor in compliance with applicable code requirements and as directed by Owner's Architect or General Contractor.
   2. Where penetrations through fire-rated walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor as required by code and as directed by Owner's Architect or General Contractor.

3.08 TESTING / WARRANTY

A. Copper Cable testing
   1. Testing of all copper wiring shall be performed prior to system acceptance.
   2. One hundred percent of the permanent installed links shall be tested for conformance to the manufacturers guaranteed performance levels as specified in the manufacturer's Extended Product Warranty platform.
      a. Any pairs not meeting or exceeding the requirements of the guaranteed performance levels shall be brought into compliance by the contractor, at no charge to the owner.
      b. All cabling shall exceed the specifications of ANSI/TIA-568-C.2 (specific to the Category standards the cabling is manufactured to) by the margins (headroom) specified in the manufacturer's Extended Product Warranty platform.
   3. One hundred percent of the backbone cabling pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage.
   4. The Low Voltage Contractor shall utilize Level III test equipment for all unshielded twisted pair cabling.
   5. All test equipment shall be updated with the latest firmware and software releases available from the manufacturer of the test equipment.
   6. All test equipment shall include valid proof of calibration within **6** months of the testing date. The calibration shall utilize the manufacturer's recommended calibration practices.
   7. Backbone/riser cables rated above Category 5e shall be tested according to test set manufacturer's instructions utilizing the latest firmware and software.
      a. Testing shall include all of the electrical parameters.

b. The detailed test results shall include the following:
    1) Wire Map
    2) Length
    3) Insertion loss
    4) Near-End Cross Talk (NEXT)
    5) Power Sum Near-End Crosstalk (PSNEXT)
    6) Equal-Level Far End Crosstalk (ELFEXT)
    7) Power Sum Equal-Level Far-End Crosstalk (PSELFEXT)
    8) Return Loss
    9) Propagation delay
    10) Delay skew
8. Complete, end to end, test results must be submitted to Engineer for review.

B. Optical Fiber Cable Testing
1. All fiber testing shall be performed on all fibers in the completed end to end system.
2. Testing shall consist of a bidirectional end to end OTDR trace performed per EIA/TIA 455-61 or a bidirectional end to end power meter test performed per EIA/TIA 455-53A. Optical Certification testers may be used if approved in advance by the engineer of record.
3. The system loss measurements shall be provided at (850 and 1310 nanometers for multimode fibers) and (1310 and 1550 for single mode fibers).
4. Pre-installation cable testing
    a. The Low Voltage Contractor shall test all fiber cable prior to the installation of the cable and provide **exp** U.S. Services Inc. with those test results prior to installation.
    b. The Low Voltage Contractor shall assume all liability for the replacement of the cable should it be found defective.
5. Loss Budget
    a. Fiber links shall have a maximum loss of: Allowable cable loss per km)(km of fiber in link) + (.4dB)(number of connectors) = maximum allowable loss
    b. A mated connector to connector interface is defined as a single connector.
    c. Any link not meeting the requirements of the standard shall be brought into compliance by the Low Voltage Contractor, at no charge to Owner.
    d. Documentation shall be provided in both hard copy and Compact Disk to the point of contact.
6. Complete, end to end, test results must be submitted to **exp U.S. Services Inc.** for review (provide both PDF format and native tester file format).

C. Manufacturer Warranty
1. The Low Voltage Contractor shall maintain existing warranties within the existing facility and coordinate with owner's IT department to facilitate preserving the existing warranties. There shall be no impact upon the existing warranty.
2. The Low Voltage Contractor shall provide and support the manufacturer's twenty-five (25) year extended warranty for the premises fiber cabling solution Material and Installation Guarantee.
3. The Low Voltage Contractor shall provide and support the manufacturer's twenty (20) year extended warranty for the premises copper cabling solution Material and Installation Guarantee.
4. Under the Extended Product the manufacturer shall replace any and all defective product or product not functioning to the levels guaranteed at the time of the warranty issue at the manufacturer's cost.
5. The manufacturer shall engage an authorized manufacturer's reseller to repair or replace any such defective product on behalf of the manufacturer at no cost to the owner.
6. The Extended Product Warranty shall include a minimum one (1) year installation warranty for the premises copper and optical cabling to correct all installation related problems/ issues at no cost to the owner.

3.09 COMPLETION OF WORK

A. At the completion of the Work, the Low Voltage Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract.

B. All clean up, restoration, and removal noted above shall be by the Low Voltage Contractor and at no additional cost.

C. If the Low Voltage Contractor fails in its duties under this paragraph, Owner may upon notice to the Low Voltage Contractor perform the necessary clean up and deduct the costs there of from any amounts due or to become due to the Low Voltage Contractor.

3.10 INSPECTION

A. On-going inspections shall be performed during construction by the Project Manager and/or System Engineer. All work shall be performed in a high quality manner and the overall appearance shall be clean, neat and orderly.

END OF SECTION

SECTION 271500

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED WORK AND REQUIREMENTS

A. Section 270500 – Common Work Results for Communications

B. Section 270526 – Grounding and Bonding for Communications Systems

C. Section 270528 – Pathways for Communications Systems

D. Section 271100 – Communications Equipment Room Fittings

E. Section 271300 – Communications Backbone Cabling

F. Section 281300 – Electronic Access Control Systems

1.03 GENERAL

A. Use of a manufacturer's name and model or catalog number is for the purpose of establishing standard of quality, general configuration, and operating characteristics desired only. This specification is intended to be a minimum standard for function, operation and performance. Equipment catalog numbers are listed to establish this minimum.

B. Section Includes:
   1. UTP cabling
   2. Cable connecting hardware, patch panels, and cross-connects.
   3. Telecommunications outlet/connectors.
   4. Cabling system identification products.
   5. Cable management system.

1.04 SUMMARY OF WORK

A. Furnish and install complete with all accessories a Category 6 Structured Cabling System (SCS). The SCS shall serve as a vehicle for transport of data, video and voice telephony signals throughout the network from designated demarcation points to outlets located at various desks, workstation and other locations as indicated on the contract drawings and described herein.

B. The Low Voltage Contractor shall maintain a current copy of the design drawings, specifications, installation schedule, equipment submittals and shop drawings at the job site at all times. These documents shall be made available to the Owner/Engineer at their request.

C. Throughout the project, the Low Voltage Contractor shall provide levels of manpower necessary to meet all construction schedules.

D. Wiring utilized for data and voice communications shall originate at owner provided switches and concentrators either wall mounted, in vertical free standing equipment racks, and/or enclosed wall mounted vertical equipment racks located at the Telecommunications Equipment Room (TER), the Main Cross-connect (MC), the Intermediate cross-connect (IC), and/or the Telecommunications Room (TR) location(s). All connectivity, wiring, terminations and patch bays between these designated demarcation points and outlet locations designated on the plans shall be considered part of the contract. Telecommunication Outlets (TO) shall be furnished, wired and installed by the SCS Low Voltage Contractor.

E. The system shall utilize a network of unshielded twisted pair, riser, tie and station cables. Cables and terminations shall be provided and located as shown and in the quantities indicated on the drawings.
   1. All cables and terminations shall be identified and labeled per owner specifications at all locations.
   2. All cables shall terminate in an alpha-numeric sequence at all termination locations.

F. All copper cable terminations shall comply with, and be tested to ANSI/TIA/EIA 568-B standards for Category 6 installations.

G. Available and unused pairs between the ER (MDF) and TR (s) (IDF) shall be terminated, tested and shall be identified as spare at each location.

H. Station cables shall be provided by the Owner.

1.05 REFERENCES

A. ANSI/TIA/EIA 568-B.1 - Commercial Building Telecommunications Wiring Standards, General requirements.

B. ANSI/TIA/EIA 568-B.2 - Commercial Building Telecommunications Wiring Standards, Balanced Twisted Pair Cabling Components.

C. ANSI/TIA/EIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces.

D. ANSI/TIA/EIA 606-A – Administration Standards for Commercial Telecommunications Infrastructures.

E. International Standards Organization/International Electrotechnical Commission (ISO/IEC) 11801.

F. Underwriters Laboratories (UL®) Cable Certification and Follow up Program.

G. National Electrical Manufacturers Association (NEMA).

H. American Society for Testing Materials (ASTM).

I. National Electric Code (NEC®), 1999

J. Institute of Electrical and Electronic Engineers (IEEE).

K. UL Testing Bulletin.

L. American National Standards Institute (ANSI) X3T9.5 Requirements for UTP at 100 Mbps.

M. BICSI – TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM) most recent version.

1.06 RESPONSIBILITY

A. The term Low Voltage Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.

B. The Low Voltage Contractor for this project shall be contracted by the General Contractor.

1.07 DEFINITIONS

A. Structured Cabling System (SCS): A SCS is defined as all required equipment and cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, telecommunication outlets, work area cords, UTP installed and configured to provide computer data and voice connectivity from each data or voice device to the network file server or voice network/switch designated as the service point of the local area network.

B. Work Area: The connection between the information outlet and the station equipment in the work area consists of cords, adapters, and other transmission electronics.

C. Horizontal Cabling: The Horizontal Cabling subsystem Provides connections from the horizontal cross connect to the Telecommunication Outlets (TOs) in the work areas. It consists of the horizontal transmission media, the associated connecting hardware terminating this media and IOs in the work area. Each floor of a building is served by its own Horizontal Subsystem.
   1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlets/connectors be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
   3. Bridge taps and splices shall not be installed in the horizontal cabling.

D. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

E. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

F. Riser Backbone: The Riser Backbone subsystem links the main cross connect (MC) and telecommunications rooms (TR). It consists of the backbone transmission media between these locations and the associated connecting hardware terminating this media. It is normally installed in a star topology, with first-level backbone cables beginning at the main cross connect. If needed, second-level backbone cables begin at intermediate cross connects.

G. Campus Backbone: A Campus Backbone is used when a distribution system encompasses more than one building. The components and cables that provide the link between buildings constitute the Campus Backbone. This subsystem includes the backbone transmission media, associated connecting hardware terminating this media, and electrical protection devices to mitigate harmful voltages when the media is exposed to lightning and/or power surges. It is normally first-level backbone cables beginning at the main cross connect in the equipment room of the hub building and extending to the intermediate cross connect in the equipment room of a satellite building.

H. Equipment Subsystem: The Equipment Subsystem consists of shared (common) electronic communications equipment in the equipment room, main cross connect or telecommunications closet and the transmission media required to terminate this equipment on the distribution hardware.

I. The Administration Subsystem: The Administration Subsystem links all of the subsystems together. It consists of labeling hardware for providing circuit identification and patch cords or jumper wire used for creating circuit connections at the cross connects.

1.08 BIDDING

A. At the time of bid, in addition to a complete bid including all pricing information, provide the following:
   1. A detailed description of any and all additions, deletions or exceptions taken to the bid documents. Include the reasons why changes are being proposed.
   2. Detailed breakout of all requested alternate pricing.
   3. A price to furnish and install each individual media type and system component under this proposed work.
   4. Manufacturer’s original equipment cut sheets for each product for use on this project.
   5. Add/Delete pricing for all type station outlet configurations as shown on drawings.

1.09 SUBMITTALS

A. Product Data
   1. Provide manufacturer's catalog information showing dimensions, colors, and configurations.
   2. Submittals shall include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for the following:
      a. All connectors and required tooling.
      b. All termination system components for each cable type.
      c. All grounding and building entrance protection surge suppression system components.
   3. For UTP copper cable, provide manufactures technical data sheet that includes the following installation data for each type used:
      a. Mutual Capacitance
      b. Impedance
      c. DC Resistance
      d. Attenuation (Insertion Loss)
      e. Return Loss
      f. Worst Pair-to-Pair Near End Crosstalk (NEXT)
      g. Power Sum Near End Crosstalk (PSNEXT)
      h. ELFEXT (ACRF)
      i. Power Sum ELFEXT (PSACRF)
   4. All submitted product sheets containing more than one product or multiple product options shall have the submitted product clearly identified for review with all options highlight as intended for review.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. Cabling administration drawings and printouts.
   3. Wiring diagrams to show typical wiring schematics, including the following:
      a. Cross-connects.
      b. Patch panels.
      c. Patch cords.
      d. Coaxial splitters, taps, and amplifiers (with calculated dB losses per leg).
   4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

C. Pre-Qualification Certificate
   1. The Low Voltage Contractor shall submit the following documents with project proposal:
      a. A letter of approval from the manufacturer indicating completion of pre-qualification requirements by installing vendor.
      b. Submit proof from manufacturer of vendor's good standing in manufacturer's qualification program**.**
      c. Submit training certificates for design, engineering and installation of the proposed products awarded to the Low Voltage Contractors assigned project manager and installers. (Only installers with manufacturer's certificate of competency in installing proposed SCS will be acceptable for this project).
      d. The Low Voltage Contractor must be a Corning Cable Systems LANscape® Solutions Extended Warranty SM Program (EWP) Member and must provide written warranty certification and evidence of current EWP program membership.
      e. The Low Voltage Contractor must offer a twenty (20) year extended warranty for the premises copper cabling solution Material and Installation Guarantee and must be able to perform service under this warranty.
      f. The Low Voltage Contractor shall guarantee at the time of the bid that all Category 6 cabling and components meet or exceed specifications (including installation) of ANSI/TIA/EIA-568-B.1, 568-B.2, 568-B.3 and 569.

2. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
    a. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
    b. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
    c. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

D. Material Provided: The successful Low Voltage Contractor shall be certain that all correct parts are ordered per Products Section of this document and installed in accordance with manufacturers design and installation guidelines. Low Voltage Contractor shall submit complete parts and part numbers to Engineer prior to installation of equipment for approval.

E. Warranty Documentation
1. Warranty shall be for a minimum of 20 years for the SCS.
2. Complete documentation regarding the manufacturer's warranty shall be submitted as part of the proposal. This shall include, but is not limited to: a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.
3. A systems application assurance manual documenting the vendor supported applications and application guidelines shall be provided as part of the submittals

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
1. Test each pair of UTP cable for open and short circuits.

1.11 QUALIFICATIONS

A. Manufacturer
1. The products specified in this specification shall be supplied by a single manufacturer, with the exception of 1. Data racks and other hardware that is not defined as part of the channel test configuration by ANSI/TIA/EIA 568-B.

B. General Requirements: Comply with TIA/EIA-569-A.

C. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Ladder tray, conduit
3. Straps and other devices.

D. Low Voltage Contractor
1. The Low Voltage Contractor selected to provide the installation of this system shall be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein.
2. The Low Voltage Contractor shall utilize the authorized manufacturer components and distribution channels in provisioning this Project.
3. The Low Voltage shall have a minimum of five (5) years of recent experience on structured cabling systems of similar type and size.
4. The Low Voltage Contractor and design firm shall be in compliance with all federal, state and local statutes regarding qualifications of firms.
5. The Low Voltage Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.
6. The Low Voltage Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and Category 5e and Category 6 metallic premise distribution systems.
7. The Low Voltage Contractor shall have personnel who are adequately trained in the usage of such tools and equipment.

8. The Low Voltage Contractor shall submit a resume of qualification with the vendor's proposal indicating the following:
    a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.
    b. A technical resume of experience for the Low Voltage Contractor's Project Manager and on-site installation supervisor who will be assigned to this project.
    c. A list of technical product training attended by the Low Voltage Contractor's personnel that will install the SCS system.
    d. Any Sub-Contractor, who will assist the SCS Low Voltage Contractor in performance of this work, shall have the same required training and certification as the Low Voltage Contractor.

1.12 CABLING BASIC REQUIREMENTS

A. Cable Pathway: Extension of all data and voice cables shall be within raceway, conduit, cable tray or other designated cable delivery system.

B. Hardware: Required hardware includes, but is not limited to, termination blocks, fastening devices, data outlets, voice outlets, connectors and all required accessories to comply with this specification.

1.13 PRODUCT WARRANTY AND APPLICATION ASSURANCE

A. Structured cabling system (SCS) Extended Product Warranty and Application Assurance Program
    1. Extended Product Warranty
        a. The Extended Product Warranty covers product defects for all passive components of the SCS. Passive components are defined as those exhibiting no gain or contributing no energy. The manufacturer shall warrant, from the date a Registration Certificate is issued by the manufacturer to the end-user, the following:
        b. The passive products that comprise the registered SCS will be free from manufacturing defects in material or workmanship under normal and proper use;
        c. All SCS approved passive cabling products that comprise the registered SCS solution exceed the specification of TIA 568-B.1, B.2, B.3 and exceed ISO/IEC 11801 standards and will conform to the performance specifications of the manufacturer's associated product data sheet in effect at the time the Registration Certificate is issued;
        d. The installation will exceed the insertion and return loss, attenuation and near end crosstalk (NEXT) requirements of TIA 568-B and the ISO/IEC 11801 standards for cabling links/channel configurations specified in these standards.
            1) That each SCS channel comprised exclusively of manufacturer's Category 6 passive products, end-to-end, shall be capable of delivering 1.0 Gbps to the workstation in accordance with application standards..
        e. This extended Product Warranty shall be applicable to the SCS only on the original site of installation. Under the Extended Product Warranty, manufacturer shall either repair or replace the defective product itself at manufacturer's cost. And in the U.S.A., manufacturer shall pay an Authorized manufacturer's Reseller for the cost of labor to repair or replace any such defective product on behalf of the manufacturer.
    2. Application Assurance
        a. Application Assurance covers failure of the SCS to operate the applications which the system was designed to support, as well as additional application(s) defined below. Manufacturer shall warrant that the registered SCS solution will be free from failures which prevent operation of the specific applications for which the original SCS was designed.
        b. The Application Assurance Program shall also cover those applications identified in the current (at the time of installation) SCS Performance Specifications; and

c. In accordance with application standards specifications, any applications introduced in the future by recognized standards or user forums that use ANSI/TIA/EIA 568-B or ISO/IEC 11801 components and link/channel specifications for cabling.

3. Term of Warranty
   a. For a minimum twenty years from the date of issuance of the Registration Certificate or installation, whichever is later.
4. Persons / Entity Covered
   a. This Limited Warranty shall be for the benefit of the person or entity to which the manufacturer's SCS Registration Certificate is issued and any successor Transferable in interest to the site in which such System was originally installed by the manufacturer or an Authorized manufacturer's Reseller.
   b. If manufacturer repairs the product, it may use new or reconditioned replacement parts. If manufacturer chooses to replace the product, manufacturer may replace it with a new or reconditioned one of the same or similar design. Any such repair or replacement will be warranted for either (a) 90 days or (b) the remainder of the original 20-year warranty period, whichever is longer.

1.14 SPECIAL REQUIREMENTS FOR CABLE ROUTING AND INSTALLATION

A. Cabling
   1. All communications cabling used throughout this project shall comply with the requirements as outlined in the National Electric Code (NEC®) Articles 725, 760, 770, and 800 and the appropriate local codes.
   2. All copper cabling shall bear appropriate markings for the environment in which they are installed.

B. Cable Pathway
   1. The Low Voltage Contractor shall adhere to the manufacturers' requirements for bending radius and pulling tension of all data and voice cables.
   2. All cabling shall be run in and supported by cable pathways that are installed solely for the purpose of supporting low voltage communications cabling.
   3. Cables shall not be attached to lift out ceiling grid supports or laid directly on the ceiling grid.
   4. Cables shall not be attached to or supported by fire sprinkler heads or delivery systems or any environmental sensor located in the ceiling air space.
   5. Cables shall maintain adequate separation from EMI. and heat sources such as lighting fixtures etc

C. Fire Stopping
   1. Sealing of openings around the exterior of the sleeves or openings between floors, through rated fire and smoke walls, existing and created by others shall be the responsibility of others. Sealing of openings between floors used by Low Voltage Contractor for cable pass through, sealing of space internal to the sleeves used for cable pass through and sealing of openings around the exterior of sleeves installed by the Low Voltage Contractor shall be the responsibility of the Low Voltage Contractor.
   2. Sealing material and application of this material shall be accomplished in such a manner which is acceptable to the local fire and building authorities having jurisdiction over this work.
   3. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the Low Voltage Contractor work.
   4. Any openings created by or for the Low Voltage Contractor and left unused shall also be sealed as part of this work.

D. Low Voltage Contractor Responsibility
   1. The Low Voltage Contractor shall be responsible for damage to any surfaces or work disrupted as a result of his work. Repair of surfaces, including painting, shall be included as necessary.

1.15 WORK EXTERNAL TO THE BUILDING

A. Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification and the applicable drawings.

PART 2 - PRODUCTS

2.01 EQUIVALENT PRODUCTS

A. Equivalent product(s) may be considered for substitution for those products specified, however, the equivalent product(s) must be approved and show demonstrated and documented equivalence to the product(s) specified.

B. Documentation shall include, but is not limited to: product samples, data sheets, and actual test data.

C. The request for product substitution, and supporting documentation, must be submitted, in writing 5 (five) days prior to submitting the bid.

D. Written approval for product substitution must be submitted with the bid.

2.02 HORIZONTAL CABLING

A. Horizontal cabling shall be Category 6 4-pair unshielded twisted pair (UTP) cabling that meets the channel requirements specified above.
   1. Cable color:
      a. Gray cable color (CAT5E installations only)
      b. Blue cable color for voice/data
      c. Yellow cable color for CCTV or video

B. Acceptable Horizontal Cabling:
   1. Commscope Ultra

2.03 GUARANTEED CHANNEL PERFORMANCE

A. Category 6 Guaranteed Channel Performances
   1. All copper cable and apparatus shall conform to the Category 6/ Class E Channel Performance Specification.
   2. The copper cable and apparatus channel performance shall be measured over the full 100 meters (328 feet) length and include 4 or 6 connection points.
   3. The specifications for the 4 pair UTP Category 6 channel are divided into two primary groups based upon high performance and premium performance cable. The Category 6 channel shall consist of all cable and components with four connections that comprise the full 100 meter (328 feet) length circuit from the Hub/Server/LAN Electronics port located in the Telecommunications Closet or the main data administration location to the voice/data/video/imaging device port located at the User Work Station.
   4. The Category 6 cable and Category 6 channel components shall be manufactured by a single manufacturer. The manufacturer shall warrant the Category 6 channel cable, components, and applications for a period of 20 years.
   5. The 20 year warranty shall be a transferable warranty and include all labor to replace any defective components as well as the component replacement.
   6. The Category 6 channel with four (4) connections shall have a minimum of 10dB Attenuation to Crosstalk Ratio (ACR); across the full frequency range of 1MHz.
   7. The Category 6 solution shall provide a total useable bandwidth of 250 MHz and will deliver lab verified performance of 5dB better than all Category 6 crosstalk and return loss requirements for standards-compliant installations.
   8. The Category 6 solution shall provide a total usable bandwidth in excess of 400 MHz and will deliver lab verified performance channel performance of 8dB above all Category 6 crosstalk

requirements and 6dB above all Category 6 return loss requirements for standards-compliant installations.

9. The Delay Skew on the 90 meter channel shall not exceed 30 ns.
10. The Category 6 cable and components shall be electrically compatible with future networks and backward compatible with existing Category 3, 5, 5e.
11. The Category 6 components shall be engineered and manufactured to compensate for any Category 3, 5 or 5e component crosstalk and shall provide at least Category 3, 5 or 5e performance in all of the customer's existing installed base of voice/data/video.
12. The Category 6 cable and components shall be physically compatible with existing installed base of equipment.
13. The Category 6 cable and components shall not require special cords, specialty tools or special installation requirements.

2.04 OUTLETS

A. Outlet Locations: Unless otherwise noted on the floor plans or within this document, all voice and data wall outlets for 24 AWG copper cable shall be:
   1. 8-position/ 8-conductor modular outlets
   2. Insulation displacement
   3. Support Universal applications in a multi-vendor environment, accepting modular RJ-45 plugs. .
   4. Provided with blank module inserts for all unused module locations. Jack module arrangement is shown on the drawings. Provide color coded inserts at each outlet, termination block and at patch panels as shown on the drawings.
   5. Mounted in one, two or three gang utility outlet boxes.
   6. Equipped with EIA/TIA-T568A and EIA/TIA-T568B universal wiring labels.

B. Faceplates
   1. General Requirements
      a. Faceplates shall be available in single, duplex, triplex, quadplex, or sixplex arrangements in a single gang configuration.
      b. The outlets shall be capable of being installed in any modular faceplate, frame, flush mounted box or surface-mounted box avoiding the need for special faceplates.
      c. Faceplate outlet openings shall be numbered on both sides for installation and maintenance identification.
      d. Faceplate shall be installed with the number of ports as required by the designated outlet. Each unused port shall contain a blank insert.
   2. Modular Flush Mounted Faceplates
      a. Faceplates shall be High-impact, flame retardant, UL-rated 94V-0 thermoplastic.
      b. Color shall match Architects finish schedule.
   3. Metal Modular Faceplates
      a. Metal faceplates shall be available in stainless steel.

C. Category 6 Gigabit outlets
   1. Approved Category 6 Jacks:
      a. CommScope – KJ610 Series
   2. All Category 6 outlets shall meet or exceed Category 6 transmission requirements for connecting hardware, as specified in ANSI/TIA/EIA 568-B.2-1 Commercial Building Telecommunications Cabling Standard, ISO/IEC 11801:2002 Second Edition and be part of the UL® LAN Certification and Follow-up Program.
   3. The Category 6 outlets shall be backward compatible with Category 5e, 5 and 3 cords and cables.
   4. The outlet shall use either the EIA/TIA-T568A or EIA/TIA-T568B wiring. The EIA/TIA-T568B wiring scheme shall be used.
   5. General specifications:

a. Meets or exceeds the mechanical, electrical, and clearance specifications in FCC Rules and Regulations, Part 68, Subpart F
b. Meet or exceed the Category 6 requirements in ISO/IEC 11801, CENELEC EN 50173, and TIA/EIA568B
c. Certifications: UL Listed, CSA Certified and AUSTEL approved.

6. Color of jacks:
   a. Data – Outlet color shall be black.
   b. Voice – Outlet color shall be black.

2.05 MODULAR PATCH PANELS

A. Approved Modular Patch Panels:
   1. CommScope CAT 6

B. Approved Horizontal Wire-Managers:
   1. Panduit

C. Category 6 Modular Patch Panels
   1. The Category 6 modular jack panels shall meet or exceed the proposed Category 6 standards requirements in ISO/IEC 11801 (2002), CENLEC EN 50173 (2002) and ANSI/TIA/EIA 528-B.2-1 and shall be UL Listed.
   2. The panel shall be capable of handling either T568A or T568B wiring.
   3. The panel shall have 110 style IDC punch downs
   4. The jack panels shall be 19-inch rack mountable.
   5. The Category 6 patch panel shall have 24/48 port configuration (Type T568B)
   6. Provide patch cord organizers between each modular patch panel

2.06 COPPER PATCH CORDS

A. Category 6 Patch Cords:
   1. Patch cords are provided by owner.

2.07 STATION CABLE

A. Category 6 Station Cables:
   1. Station Cables are provided by owner.

2.08 GROUNDING SYSTEM AND CONDUCTORS

A. Grounding Conductor
   1. The SCS Low Voltage Contractor shall provide and install a #6 AWG ground wire between ground bars located at the TER and the building main service ground point. Termination at the main service ground point shall be made by the electrical contractor. This ground conductor shall be utilized for equipment, termination, equipment rack and computer equipment grounding.

B. Bonding and Grounding
   1. Communication bonding and grounding shall be in accordance with the NEC® and NFPA, ANSI/TIA/EIA 607 and all local codes and practices.
   2. Horizontal cables and equipment shall be grounded in compliance with ANSI/NFPA 70 and local requirements and practices.
   3. Horizontal equipment includes cross connect frames, patch panels and racks, active telecommunication equipment and test apparatus and equipment.

C. Telecommunications Bonding Backbone
   1. Always provide and install a Telecommunications Bonding Backbone utilizing a #6-AWG or larger bonding conductor that provides direct bonding between the telecommunication equipment room (TER) and telecommunications closets (TR's). The SCS Low Voltage

Contractor shall refer to the BICSI TDMM tenth edition, chapter 10, table 10.1 for sizing the bonding backbone cable. This is part of the grounding and bonding infrastructure (part of the telecommunications pathways and spaces in the building structure), and is independent of equipment or cable.

2. Always provide Telecommunications Bonding Backbone when using non-shielded backbone copper cable.

PART 3 - EXECUTION

3.01 WORKMANSHIP

A. Components of the SCS system shall be installed in a neat, workmanlike manner.

B. Wiring color codes shall be strictly observed and terminations shall be uniform throughout the system.

C. Identification markings and systems shall be uniform.

D. ANSI/TIA/EIA 568-B wiring codes shall standardize all SCS wiring.

3.02 WIRING METHODS

A. Wiring Method: All cables shall be routed in conduit back to telecommunications backboard. Conceal raceway and cables except in unfinished spaces.
   1. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring Method: Provide a minimum 10’-0” of service loop/ figure eight at the telecommunications rooms for each permanent link.

D. Wiring Method: Provide a minimum of 8” of cable at each copper UTP outlet location for jack termination.

E. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

F. All conduit shall be provided with pull cords.

G. All voice and data cables shall terminate in rack mounted patch panels.

3.03 GENERAL DESCRIPTION

A. The wiring system components shall comply with all product specifications contained in Section two.

B. The structured cabling system shall consist of the Work Area, Horizontal, and Backbone – Riser, Backbone – Campus, Telecommunications Room (TR), Equipment Room (ER), Entrance Facility (EF) and Administration elements.

3.04 WORK AREA

A. Wiring and cords: Owner shall supply the wiring or cords that connect terminal devices to information outlets. This includes mounting cords and connectors, as well as extension cords.

3.05 HORIZONTAL

A. Horizontal Cabling.
   1. The Low Voltage Contractor shall supply horizontal cables to connect each information outlet to the backbone subsystem on the same floor.

2. Unless otherwise noted on the floor plans or within this document, the type of horizontal cables used for each work location shall be 4-pair unshielded twisted pair (UTP)
3. The 4-pair UTP cables shall be run using a star topology format from the administration subsystem (Telecommunications Room) on each floor to every individual Telecommunication Outlet.
4. All cable routes are to be parallel and/or perpendicular with the outside walls of the building. Alternate paths must be approved by Engineer prior to installation of the cabling.
5. The length of each individual run of horizontal cable from the administration subsystem (Telecommunications Closet) on each floor to the Telecommunication Outlet shall not exceed 295 ft (90 m).
6. The Low Voltage Contractor shall adhere to the manufactures recommendations and specifications with regard to the bending radius and pulling strength requirements of the 4-pair UTP cable during handling and installation.
7. Each run of cable between the termination block and the information outlet shall be continuous without any joints or splices.
8. In suspended ceiling and raised floor areas where walker duct, cable trays or conduit are not available, the Low voltage Contractor shall bundle station wiring with Velcro type cable ties at appropriate distances.
9. Plenum cable will be used in all appropriate areas.
10. The Low voltage Contractor shall conceal horizontal distribution wiring internally within the walls. If obstructions exist, the Low Voltage Contractor shall secure approval by Engineer prior to the use of an alternate method.
11. Every effort will be made to schedule the requirements under this Contract in such a manner so as to complete all above ceiling work prior to ceiling tile installation. In the event the Low Voltage Contractor is required to remove ceiling tiles, such Work shall not break or disturb grid and must be coordinated with the General Contractor.
12. The 4 pair UTP cable shall be Underwriter's Laboratories (UL) listed type MPR, MPP, CMR, or CMP as stated later in this section.
13. The Low Voltage Contractor shall provide shop drawings with detailed cable run diagrams for cable runs within raised floors detailing exact locations of cable for review and approval by Engineer after coordination with other contractors, architect and general contractor and prior to installation.
14. Conduit runs installed by the Low Voltage Contractor should not exceed 100 feet or contain more than two 90 degree sweeping bends without utilizing appropriately sized pull boxes.
15. Station cables and tie cables installed within ceiling spaces shall be routed through these spaces at right angles to electrical power circuits.

B. Work location information outlets: Supply and install outlets as shown on drawings.

3.06 ADMINISTRATION

A. The administration subsystem shall consist of wiring blocks and or patch panels for termination of copper cables. All wall field layouts to be as detailed on drawings or as approved by Engineer prior to installation.

B. Fields: Separate termination fields shall be created for voice and data applications if both are wall mounted.

C. Termination blocks: Termination blocks that require rotation after connection of horizontal/vertical wiring shall not be allowed.

D. Cross-connect wire, patch cords: The Owner shall provide cross-connect wire, copper patch cords for cross-connection and inter-connection of termination blocks and patch panels
   1. Jumper type: The type of jumper cables shall depend on ANSI/EIA/TIA Category 6 applications and the termination block used, i.e. a punch panel, a patch panel termination block and be part of the manufacturers total channel solution.

3.07 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.08 INSTALLATION

A. All installation shall be done in conformance with ANSI/EIA/TIA 568-B standards, federal and local standards and the SCS manufacturer Design and Installation guidelines.
   1. The Low Voltage Contractor shall ensure that the maximum pulling tensions of the specified distribution cables are not exceeded and cable bends maintain the proper radius during the placement of the facilities. Failure to follow the appropriate guidelines will require the Low Voltage Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation at no additional cost to the owner. This shall also apply to any and all damages sustained to the cables by the Low Voltage Contractor during the implementation.
   2. The Low Voltage Contractor shall make provisions so that all cabling is stored within a temperature controlled space to ensure that cabling is unspooled, manipulated, and worked with only when the cabling is within the manufacturer's installation temperature specifications and free of condensation.

B. Bonding and Grounding
   1. The Low Voltage Contractor shall be responsible for providing an approved ground at all newly installed distribution frames, and/or insuring proper bonding to any existing facilities.
   2. The Low Voltage Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and framework.
   3. All grounds shall consist of #6 AWG or larger (As required) copper wire and shall be supplied from an approved building ground and bonded to the main electrical ground.
   4. Grounding must be in accordance with the NEC, NFPA and all local codes and practices.

C. Power Separation: The Low Voltage Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus. All SCS equipment and terminations must maintain proper separation from sources of EMI as per ANSI/TIA/EIA 562 B2 and BICSI installation practices.

D. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

E. Miscellaneous Equipment: The Low Voltage Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, wire molding (MC & TR locations), miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the System.

F. Special Equipment and Tools: It shall be the responsibility of the Low Voltage Contractor to furnish any special installation equipment or tools necessary to properly complete the System. Tools shall include, but are not limited to:
1. Tools for terminating cables,
2. Testing and splicing equipment for copper cables,
3. Communication devices,
4. Jack stands for cable reels,
5. Cable wenches.

G. Identification/Labeling
1. The Low Voltage Contractor shall be responsible for generating and placing printed labels for all cables and cords, distribution frames, and outlet locations i.e., 2N-001-V, 2N-001-D1, 2N-001-D2 at the time of delivery. Adhere to existing owner standards if exist. All horizontal cables shall be labeled within 4” of terminations on each end.
2. Labels shall not be written by hand.
3. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
4. Comply with ANSI-J-STD-607-A.

H. Identification:
1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   a. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
2. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
3. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
4. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.
5. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
6. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets,

backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

7. Cable and Wire Identification:
   a. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   b. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
   c. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      1) Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
      2) Label each unit and field within distribution racks and frames.
   d. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
   e. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
8. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

I. Cable Records: The Low voltage Contractor shall maintain conductor polarity (tip and ring) identification at the main equipment room (switch room), risers, and station connecting blocks in accordance with industry practices.

J. As Built Documentation
   1. Upon completion of the project, Low Voltage Contractor is to prepare "As Built" documentation showing actual site conditions and installation as constructed.
   2. Provide copies of such documentation to the Owner as mentioned below.
      a. Upon completion of system installation, Low Voltage Contractor shall provide to Owner for its records the following:
         1) MC, TR and EF Diagrams which shall include:
            a) Cable routing
            b) Position of all components and
            c) Detailed layout of the wall field
            d) Labeling plan.
         2) Riser Distribution Plan
         3) Campus Distribution Plan
         4) Fire Stop Penetrations and System ID
      b. Documentation shall be in the following format:
         1) Four (4) copies of all diagrams and drawings matching the bid documents in size and format. One (1) copy of electronic plans, drawings and diagrams provided in both PDF format and the latest version of AutoDesk AutoCAD (or Revit if applicable) on CD/DVD Rom Disc, Flash Drive or digital file transfer via email or FTP.
         2) One (1) copy of electronic project records including cut sheets, test results (provided in both PDF format and the native tester file format) and cable connectivity schedules provided on CD/DVD Rom Disc, Flash Drive or digital file transfer via email or FTP.

K. Additional Records: In addition to the engineering diagrams, the following items shall be provided by the Low Voltage Contractor: Cable Records and Assignments detailing all connections to equipment, horizontal cable or riser cable for copper.

3.09 PENETRATIONS OF WALLS, FLOORS AND CEILINGS

A. Prior consent: The Low Voltage Contractor shall make no penetration of floors, walls or ceiling without the prior consent from **exp**.

B. Sealing penetrations – The area around the exterior of the sleeve shall be sealed by the contractor who installed the sleeve, the area internal to the sleeve shall be sealed by the Low Voltage Contractor who pulled or placed the cables.
   1. Where penetrations through acoustical walls or other walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor in compliance with applicable code requirements and as directed by Owner's Architect or General Contractor.
   2. Where penetrations through fire-rated walls for cableways have been provided for the Low Voltage Contractor or made by the Low Voltage Contractor such penetrations shall be sealed by the Low Voltage Contractor as required by code and as directed by Owner's Architect or General Contractor.

3.10 TESTING / WARRANTY

A. Copper Cable testing
   1. Testing of all copper wiring shall be performed prior to system acceptance.
   2. 100 percent of the horizontal and riser wiring pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage.
   3. Voice and data horizontal wiring pairs shall be tested from the information outlet to the TR.
   4. The Low Voltage Contractor shall utilize Level III test equipment for all unshielded twisted pair cabling up to Category 5e.
   5. The Low Voltage Contractor shall utilize Level III test equipment for all Category 6 unshielded twisted pair cabling.
   6. Test equipment shall be updated with the latest firmware and software releases available from the manufacturer of the test equipment.
   7. All test equipment shall include valid proof of calibration within 12 months of the testing date. The calibration shall utilize the manufacturer’s recommended calibration practices.
   8. The Category 6 cable runs shall be tested for conformance to the specifications of EIA/TIA 568-B Category 6**.**
   9. Category 6 horizontal cables shall be tested according to test set manufacturers instructions utilizing the latest firmware and software.
      a. Testing shall include all of the electrical parameters.
      b. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor, at no charge.
      c. The detailed test results shall include the following:
         1) Wire Map
         2) Length
         3) Insertion loss
         4) Near-End Cross Talk (NEXT)
         5) Power Sum Near-End Crosstalk (PSNEXT)
         6) Equal-Level Far End Crosstalk (ELFEXT)
         7) Power Sum Equal-Level Far-End Crosstalk (PSELFEXT)
         8) Return Loss
         9) Propagation delay
         10) Delay skew
   10. Complete, end to end, test results must be submitted to Engineer for review. Submit test results in an organized three ring binder.

B. Manufacturer Warranty: The Low Voltage Contractor shall provide a Twenty (20) year Structured Connectivity Solution Extended Product Warranty and Application Assurance.

C. Additional Warranty: The Low Voltage Contractor shall state any additional Contractor supplied warranty.

3.11 COMPLETION OF WORK

A. At the completion of the System, the Low Voltage Contractor shall restore to its former condition, all aspects of the project site and on a daily basis, shall remove all waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract.

B. All clean up, restoration, and removal noted above will be by the Low Voltage Contractor and at no additional cost.

C. If the Low Voltage Contractor fails in its duties under this paragraph, Owner may upon notice to the Low Voltage Contractor perform the necessary clean up and deduct the costs there of from any amounts due or to become due to the Low Voltage Contractor.

3.12 INSPECTION

A. On-going inspections shall be performed during construction by the Project Manager and/or System Engineer. All work shall be performed in a high quality manner and the overall appearance shall be clean, neat and orderly.

B. The following shall be examined and shall comply satisfactorily in all instances.
   1. Is the documentation complete, including Submittals/As-Builds?
   2. Are all cables properly labeled, from end-to-end?
   3. Have all terminated cables been properly tested in accordance with the specifications for the specific category as well as tested for opens, shorts, polarity reversals, transposition and presence of AC and/or DC voltage?
   4. Is the cable type suitable for its pathway?
   5. Are the cables bundled in parallel?
   6. Have the pathway manufacturer's guidelines been followed?
   7. Are all cable penetrations installed properly and fire stopped according to code?
   8. Has the Low Voltage Contractors avoided excessive cable bending?
   9. Have potential EMI and RFI sources been considered?
   10. Is Cable Fill Correct?
   11. Are hanging supports within 1.5 meters (5 feet)?
   12. Does hanging cable exhibit some sag?
   13. Are telecommunications closet terminations compatible with applications equipment?
   14. Have Patch Panel instructions been followed?
      a. jacket removal point
      b. termination positions
      c. all pair terminations tight with minimal pair distortions
      d. twists maintained up to Index Strip
   15. Have Modular Panel instructions been followed?
      a. cable dressing first
      b. jackets remain up to the Connecting Block
      c. all pair terminations tight and undistorted
      d. twists maintained up to the Connecting Block
   16. Are connectors properly turned right side up in the Jack Panels without cables wrapped or twisted around the Mounting Collars?
   17. Have the correct outlet connectors been used.
   18. Have outlets been wired correctly? (T568B)?
   19. Is the cable jacket maintained up to the outlet?
   20. Are identification markings uniform, permanent and readable?

END OF SECTION

SECTION 275113

AUDIO/VIDEO / BACKGROUND MUSIC SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED WORK AND REQUIREMENTS

A. Division 27 - Section “Common Work Results for Communications”

B. Division 27 - Section “Grounding and Bonding for Communications Systems “

C. Division 27 - Section “Pathways for Communications Systems”

D. Division 27 - Section “Communication Equipment Room Fittings”

1.03 SUMMARY

A. Section Includes:
   1. Power amplifiers
   2. Speakers
   3. Conductors and cables
   4. Digital Signal Processors
   5. Media Converters

1.04 DEFINITIONS

A. BMG: Background Music

B. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

C. VOIP: Voice Over Internet Protocol (IP)

D. VU: Volume unit.

E. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.05 RESPONSIBILITY

A. The term Low Voltage Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives of this specification document and to produce the finished product as described here-in.

B. The Low Voltage Contractor for this project shall be contracted by the General Contractor.

1.06 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.

1.07 SUBMITTALS

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

B. Shop Drawings: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Rack arrangements.
   3. Wiring Diagrams: For power, signal, and control wiring.
      a. Identify terminals to facilitate installation, operation, and maintenance.
      b. Single-line diagram showing interconnection of components.
      c. Cabling diagram showing cable routing.

C. Qualification Data: For qualified Installer.

D. Field quality-control reports.

E. Operation and Maintenance Data: For public address and mass notification systems to include in emergency, operation, and maintenance manuals.

1.08 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
   1. Personnel certified by NICET as Audio Systems Level II Technician.

B. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.
   1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.

C. Source Limitations: Obtain public address and mass notification systems from single source from single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NFPA 70.

1.09 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

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.

PART 2 - PRODUCTS

2.01 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:
   1. Selectively connect any zone to any available signal channel.
   2. Selectively control sound from microphone outlets and other inputs.

3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
4. Produce multiple channels of high-quality background music, individual channels of background music shall be selectable by zone.
5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
6. Play pre-recorded messages triggered by controllers. Pre-recorded messages shall be selectable by zone.
7. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of nonuniform coverage of amplified sound.

2.02 EQUIPMENT AND MATERIAL REQUIREMENTS

A. Refer to drawings and one-line diagrams for equipment components and requirements.

PART 3 - EXECUTION

3.01 WIRING METHODS

A. Wiring Method: All Cabling shall be routed in conduit.

B. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

C. Wiring Method: Conceal conduits and cables in accessible ceilings, walls, and floors where possible.

D. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.02 INSTALLATION OF RACEWAYS

A. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.03 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:
   1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
   2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
   3. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
   5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceiling by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches (300 mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.04 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Equipment Cabinets and Racks:
1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

D. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

E. Wall-Mounted Outlets: Flush mounted.

F. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

G. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 12 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 14 AWG.

H. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

I. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

J. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

K. All speakers hung in front of house and back of house areas shall be supplied with a safety cable as a secondary means of support.

3.05 TERMINATIONS

A. Contractor to provide all AV terminations.

B. All connectors carrying audio should be of the “solder-on” type whenever possible. No compression, crimp, or IDC type connectors are to be used in the audio signal path. Equipment that is manufactured using “Phoenix” style connectors, main amplifier speaker connections, etc. are not included in this request. The request is for Soldered connectors, rather than “Crimp” style

where ever physically and logically possible. If a connector is in question, please coordinate type of connecter with Engineer prior to installation.

C. All connectors should be wired in accordance with all applicable codes and standards. All low level audio wiring shall have the shield leads connected at both end connectors as well as the balanced audio pairs.

D. All installed wiring will be labeled at both ends in a permanent manner with a designation conforming to the blueprints.

E. All CAT6 terminations whether made in the field or preassembled shall be made with the highest quality materials and tools available and are to be tested after fabrication and again after installation to insure compliance with the applicable standards. Rubber boots for all plugs shall be provided.

F. Wiring "Service Loops" within an equipment rack should be made long enough to allow for connection to equipment located at any location within the rack. At speaker locations the wiring service loop should be long enough to allow for servicing of the speaker and to allow the wiring to be dressed neatly and as invisibly as possible without being "tight".

G. All installed equipment shall be labeled using designations conforming to the blueprints.

H. All instances of cross connection of audio devices with similar or dissimilar types such as balanced to unbalanced, etc. shall be done in accordance with published industry standards. Due to our unique environment and experience with same, coordination with SWO representative should be used to answer any specific requirements.

I. At screw terminal connections at the speakers the copper conductors shall have a anti-oxidation compound applied at time of installation/termination. A good choice is "No Ox" made by Greenlee products.

J. For all XLR, 1/4" TRS Phone, or RCA Phono type the preferred manufacturer of audio connecters is Neutrik.

3.06 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Division 26 Section "Grounding and Bonding for Communications Systems."

3.07 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:
   1. Schedule tests with at least seven days' advance notice of test performance.
   2. After installing public address and mass notification systems and after electrical circuitry has been energized, test for compliance with requirements.

3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
   a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
   b. Repeat test for each separately controlled zone of loudspeakers.
   c. Minimum acceptance ratio is 50 dB.
5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

F. Prepare test and inspection reports.
   1. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

3.08 STARTUP SERVICE

A. Perform startup service.
   1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
   2. Complete installation and startup checks according to manufacturer's written instructions.

3.09 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 6 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to 2 visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment.

3.11 PROOF OF SYSTEM PERFORMANCE

A. Upon completion of the system installation, it shall be the responsibility of the equipment supplier to perform the necessary testing and any adjustments to insure proper system operation in accordance with the Contract Documents.

B. The system shall be physically inspected by an authorized representative of the Owner to assure that all equipment is installed in a neat and workmanlike manner as called for by the plans and specifications.

C. Before the contract shall be considered complete, the Low Voltage Contractor shall conduct an operating test to verify proper performance of system. The system shall be demonstrated to operate in accordance with the requirements of these specifications. The test shall be performed in the presence of an authorized representative of the Owner. The Low Voltage Contractor shall furnish all equipment and personnel required for the tests.

D. Should such a demonstration of performance show that the Low Voltage Contractor has not properly installed the system, the Low Voltage Contractor shall make all necessary changes or adjustments at no cost to the Owner and a second performance demonstration will be arranged with the Owner and **exp** at the Low Voltage Contractor's expense (including hotel, rental car and meal expenses).

E. Should a second performance demonstration fail, the Low Voltage Contractor agrees to correct the system deficiencies under the supervision of the Owner's technical staff at no cost to the Owner.

END OF SECTION

SECTION 281300

ELECTRONIC ACCESS CONTROL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED WORK AND REQUIREMENTS

A. Section 270500 – Common Work Results for Communications

B. Section 270526 – Grounding and Bonding for Communications Systems

C. Section 270528 – Pathways for Communications Systems

D. Section 271100 – Communications Equipment Room Fittings

E. Section 271300 – Communications Backbone Cabling

F. Section 271500 – Communications Horizontal Cabling

1.03 SUMMARY

A. This Section includes a security access system consisting of a Central Station, operating system and application software, and field-installed Controllers connected by a high-speed electronic data transmission network. The security access system shall have the following:
   1. Access Control:
      a. Regulating access through doors and gates
      b. Anti-passback.
      c. Visitor assignment.
      d. Time and attendance.
      e. Surge and tamper protection.
      f. Secondary alarm annunciator.
      g. Credential cards and readers.
      h. Enrollment center.
      i. Push-button switches.
      j. Credential creation and credential holder database and management.
      k. Monitoring of field-installed devices.
      l. Reporting.

1.04 DEFINITIONS

A. ABA Track: Magnetic stripe that is encoded on track 2, at 75-bpi density in binary-coded decimal format; for example, 5-bit, 16-character set.

B. CCTV: Closed-circuit television.

C. Central Station: A PC with software designated as the main controlling PC of the security access system. Where this term is presented with initial capital letters, this definition applies.

D. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.

E. CPU: Central processing unit.

F. Credential: Data assigned to an entity and used to identify that entity.

G. dpi: Dots per inch.

H. DTS: Digital Termination Service: A microwave-based, line-of-sight communications provided directly to the end user.

I. File Server: A PC in a network that stores the programs and data files shared by users.

J. GFI: Ground fault interrupter.

K. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

L. I/O: Input/Output.

M. LAN: Local area network.

N. LED: Light-emitting diode.

O. Location: A Location on the network having a PC-to-Controller communications link, with additional Controllers at the Location connected to the PC-to-Controller link with RS-485 communications loop. Where this term is presented with an initial capital letter, this definition applies.

P. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.

Q. PCI Bus: Peripheral component interconnect; a peripheral bus providing a high-speed data path between the CPU and peripheral devices (such as monitor, disk drive, or network).

R. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.

S. RF: Radio frequency.

T. ROM: Read-only memory. ROM data are maintained through losses of power.

U. RS-232: An TIA/EIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.

V. RS-485: An TIA/EIA standard for multipoint communications.

W. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

X. TWAIN: (Technology without an Interesting Name.) A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

Y. UPS: Uninterruptible power supply.

Z. WAN: Wide area network.

AA. WAV: The digital audio format used in Microsoft Windows.

BB. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

CC. Windows: Operating system by Microsoft Corporation.

DD. Workstation: A PC with software that is configured for specific limited security system functions.

EE. WYSIWYG: (What You See Is What You Get.) Text and graphics appear on the screen the same as they will print.

1.05 SYSTEM DESCRIPTION

A. System shall consist of a PC-based Central Station and field-installed Controllers, connected by a high-speed electronic data transmission network.

B. Network connecting the Central Station and workstations shall be a Local area Ethernet network.

C. Network(s) connecting PCs and Controllers shall consist of one or more of the following:
   1. Local area Ethernet network connection shall be provided to each master controller with network card.
   2. RS-485 cable from the master controller to the sub-controllers at common Locations.

1.06 PERFORMANCE REQUIREMENTS

A. Security access system shall use a single database for access-control and credential-creation functions.

B. Distributed Processing: System shall be a fully distributed processing system so that information, including time, date, valid codes, access levels, and similar data, is downloaded to Controllers so that each Controller makes access-control decisions for that Location. Do not use intermediate Controllers for access control. If communications to Central Station are lost, all Controllers shall automatically buffer event transactions until communications are restored, at which time buffered events shall be uploaded to the Central Station.

C. System Network Requirements:
   1. Interconnect system components and provide automatic communication of status changes, commands, field-initiated interrupts, and other communications required for proper system operation.
   2. Communication shall not require operator initiation or response, and shall return to normal after partial or total network interruption such as power loss or transient upset.
   3. System shall automatically annunciate communication failures to the operator and identify the communication link that has experienced a partial or total failure.

D. Central Station shall provide operator interface, interaction, display, control, and dynamic and real-time monitoring. Central Station shall control system networks to interconnect all system components, including workstations and field-installed Controllers.

E. Field equipment shall include Controllers, sensors, and controls. Controllers shall serve as an interface between the Central Station and sensors and controls. Data exchange between the Central Station and the Controllers shall include down-line transmission of commands, software, and databases to Controllers. The up-line data exchange from the Controller to the Central Station shall include status data such as intrusion alarms, status reports, and entry-control records. Controllers are classified as alarm-annunciation or entry-control type.

1.07 SUBMITTALS

A. Refer to Division 01, “General Requirements” and Section 270500, “Common Work Results for Communications” for general Submittal information and requirements.

B. Action Submittals
   1. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
   2. Shop Drawings: For Access control. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.

c. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
d. UPS: Sizing calculations.
e. Wiring Diagrams: For power, signal, and control wiring.

3. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.
4. All submitted product sheets containing more than one product or multiple product options shall have the submitted product clearly identified for review with all options highlight as intended for review.

C. Informational Submittals
1. Seismic Qualification Certificates: For Access Control equipment, accessories, and components, from manufacturer.
a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
2. Field quality-control reports.
3. Operation and Maintenance Data: For controllers and door hardware to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
a. Lists of spare parts and replacement components recommended being stored at the site for ready access.
4. Warranty: All required Warranty information.

1.08 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NECA 1.

C. Comply with NFPA 70.

D. Electronic data exchange between video surveillance system with the access-control system shall comply with SIA TVAC.

1.09 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry

bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. Use NEMA 250, Type 4X enclosures.

5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: System components subject to corrosive fumes, vapors, and salt spray. Use NEMA 250, Type 4X enclosures.
7. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.10 WARRANTY

A. Refer to Division 01 for general warranty information and requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of Access Control System that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: shall be 3 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SYSTEM REQUIREMENTS

A. All Electronic Access Control Controllers shall be provided with the appropriate licenses as required to provide a fully functional system.

B. All control equipment and operator stations shall be provided with the appropriate user clients and licenses as required to provide a fully functional system.

C. All new access controlled doors and control points shall be connected to existing access control system.

D. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
   1. Provide Surge Protection at each end of all copper cables routed beyond the building envelope between field devices and control equipment. Refer to specification section 264313 – Surge Protective Devices for Low-Voltage Electrical Power Circuits.

2.02 SECURITY ACCESS SYSTEM CONTROLLERS

A. Manufacturers:
   1. Open Options

2.03 APPLICATION SOFTWARE

A. System Software:
   1. DNA Fusion

2.04 CARD READERS

A. Power: Card reader shall be powered from its associated Controller, including its standby power source.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the Controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Display: LED or other type of visual indicator display shall provide visual status indications and user prompts. Indicate power on/off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

D. Proximity Readers:
   1. Multi-technology passive detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
   2. The card reader shall read proximity cards in a range from contact with to at least 6 inches from the reader.

2.05 PUSH-BUTTON SWITCHES

A. Manufacturers:
   1. Securitron Magnalock Corporation; an ASSA ABLOY Group Company.

B. Push-Button Switches: Momentary-contact back-lighted push buttons, with stainless-steel switch enclosures.
   1. Electrical Ratings:
      a. Minimum continuous current rating of 10 A at 120 V ac.
      b. Contacts that will make 720 VA at 60 A and that will break at 720 VA at 10 A.
   2. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.
   3. Enclosures shall additionally be suitable for installation in the following locations:
      a. Indoors, controlled environment.
      b. Indoors, uncontrolled environment.
      c. Outdoors.
   4. Power: Push-button switches shall be powered from their associated Controller, using dc control.

2.06 DOOR AND GATE HARDWARE INTERFACE

A. Exit Device with Alarm: Operation of the exit device shall generate an alarm. Exit device and alarm contacts are specified in Division 08 Section "Door Hardware."

B. Exit Alarm: Operation of a monitored door shall generate an alarm. Exit devices and alarm contacts are specified in Division 08 Section "Door Hardware."

C. Electric Door Strikes: Use end-of-line resistors to provide power line supervision. Signal switches shall transmit data to Controller to indicate when the bolt is not engaged and the strike mechanism is unlocked, and shall report a forced entry. Power and signal shall be from the Controller. Electric strikes are specified in Division 08 "Door Hardware."

D. Electromagnetic Locks: End-of-line resistors shall provide power line supervision. Lock status sensing signal shall positively indicate door is secure. Power and signal shall be from the Controller. Electromagnetic locks are specified in Division 08 Section "Door Hardware."

2.07 CABLES

A. Manufacturers:
   1. Anixter, Inc.
   2. Belden Inc.; Electronics Division.
   3. Berk-Tek; a Nexans Company.
   4. General Cable Technologies Corporation.
   5. Mohawk/CDT; a division of Cable Design Technologies.
   6. West Penn Wire/CDT; a division of Cable Design Technologies.

B. Comply with requirements in Section 270528, “Communications Raceway Systems”.

C. Comply with requirements in Section 271500. “Communications Horizontal Cabling”.

D. RS-485 communications require 2 twisted pairs, with a distance limitation of 4000 feet.

E. PVC-Jacketed, RS-485 Cable: Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, PVC insulation, unshielded, PVC jacket, and NFPA 70, Type CMG.

F. Multiconductor, PVC Readers and Wiegand Keypads Cables: No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semi-rigid PVC insulation, overall aluminum foil-polyester tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.
   1. NFPA 70, Type CMG.
   2. Flame Resistance: UL 1581 Vertical Tray.
   3. For TIA/EIA-RS-232 applications.

G. Paired PVC Readers and Wiegand Keypads Cables: Paired, 3 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
   1. NFPA 70, Type CM.
   2. Flame Resistance: UL 1581 Vertical Tray.

H. Paired PVC Readers and Wiegand Keypads Cable: Paired, 3 pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum foil-polyester tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
   1. NFPA 70, Type CM.
   2. Flame Resistance: UL 1581 Vertical Tray.

I. Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
   1. NFPA 70, Type CMG.
   2. Flame Resistance: UL 1581 Vertical Tray.

J. Plenum-Type, Paired Lock Cable: 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
   1. NFPA 70, Type CMP.
   2. Flame Resistance: NFPA 262 Flame Test.

K. Paired Lock Cable: 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
   1. NFPA 70, Type CMG.
   2. Flame Resistance: UL 1581 Vertical Tray.

L. Paired Input Cable: 1 pair, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, overall aluminum foil-polyester tape shield with No. 22 AWG, stranded (7x30) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
   1. NFPA 70, Type CMR.
   2. Flame Resistance: UL 1666 Riser Flame Test.

M. Paired AC Transformer Cable: 1 pair, twisted, No. 18 AWG, stranded (7x26) tinned copper conductors, PVC insulation, unshielded, and PVC jacket.
   1. NFPA 70, Type CMG.

N. LAN Cabling: Comply with Section 271500. “Communications Horizontal Cabling”.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with EIA/TIA-606, "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."

C. Obtain detailed Project planning forms from manufacturer of access-control system; develop custom forms to suit Project. Fill in all data available from Project plans and specifications and publish as Project planning documents for review and approval.
   1. Record setup data for control station and workstations.
   2. For each Location, record setup of Controller features and access requirements.
   3. Propose start and stop times for time zones and holidays, and match up access levels for doors.
   4. Set up groups, facility codes, linking, and list inputs and outputs for each Controller.
   5. Assign action message names and compose messages.
   6. Set up alarms. Establish interlocks between alarms, intruder detection, and video surveillance features.
   7. Prepare and install alarm graphic maps.
   8. Develop user-defined fields.
   9. Develop screen layout formats.
   10. Propose setups for guard tours and key control.
   11. Discuss badge layout options; design badges.
   12. Complete system diagnostics and operation verification.
   13. Prepare a specific plan for system testing, startup, and demonstration.
   14. Develop acceptance test concept and, on approval, develop specifics of the test.
   15. Develop cable and asset management system details; input data from construction documents. Include system schematics and Visio Technical Drawings.

D. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.

3.03 CABLING

A. Comply with requirements in Section 270528, “Communications Raceway Systems”.

B. Comply with requirements in Section 271500. “Communications Horizontal Cabling”.

C. Wiring Method: Install cables in conduit unless otherwise indicated.
   1. Except raceways are not required in accessible indoor ceiling spaces and attics.
   2. Except raceways are not required in hollow gypsum board partitions.
   3. Conceal raceways and wiring except in unfinished spaces.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

E. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

F. For copper LAN connections and fiber-optic communication wiring, comply with Section 271500. “Communications Horizontal Cabling” and Section 271300, “Communications Backbone Cabling”.

G. Install cables without damaging conductors, shield, or jacket.

H. Boxes and enclosures containing security system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered to be accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

I. Install end-of-line resistors at the field device location and not at the Controller or panel location.

3.04 CABLE APPLICATION

A. Comply with EIA/TIA-569, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. RS-485 Cabling: Install at a maximum distance of 4000 feet.

D. Card Readers:
   1. Install number of conductor pairs recommended by manufacturer for the functions specified.
   2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from Controller to the reader is 250 feet, and install No. 20 AWG wire if maximum distance is 500 feet.
   3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the Controller.
   4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

E. Install minimum No. 16 AWG cable from Controller to electrically powered locks. Do not exceed 250 feet,

F. Install minimum No. 18 AWG ac power wire from transformer to Controller, with a maximum distance of 25 feet.

3.05 GROUNDING

A. Comply with Section 270526, “Grounding and Bonding for Communications Systems."

B. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:
   1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
   2. Bus: Mount on wall of main equipment room with standoff insulators.
   3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.06 INSTALLATION

A. Push Buttons: Where multiple push buttons are housed within a single switch enclosure, they shall be stacked vertically with each push-button switch labeled with 1/4-inch-high text and symbols as required. Push-button switches shall be connected to the Controller associated with the portal to which they are applied, and shall operate the appropriate electric strike, electric bolt, or other facility release device.

B. The contractor shall be responsible for all system programing as to provide the owner with a fully functional system per the owner’s operational requirements. Coordinate exact requirements with owner’s representative prior to installation.

3.07 IDENTIFICATION

A. In addition to requirements in this Article, comply with applicable requirements in Division 26 Section "Identification for Electrical Systems" and with TIA/EIA-606.

B. Using cable and asset management software specified in Part 2, develop Cable Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

3.08 SYSTEM SOFTWARE

A. Develop, install, and test software and databases for the complete and proper operation of systems involved. Assign software license to Owner.

3.09 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use Class 2, bidirectional, Category 5 tester. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA-568-1, "Commercial Building Telecommunications Cabling Standards - Part 1 General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA-568-B.
   2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
   3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.10 STARTUP SERVICE

A. Engage an owners representative to supervise and assist with startup service. Complete installation and startup checks according to approved procedures that were developed in " Preparation" Article and with manufacturer's written instructions.

1. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system. Refer to Division 01 Section "Demonstration and Training"

B. Develop separate training modules for the following:
   1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
   2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
   3. Security personnel.
   4. Hardware maintenance personnel.
   5. Corporate management.

END OF SECTION

SECTION 282300

VIDEO SURVEILLANCE EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED WORK AND REQUIREMENTS

A. Section 270500 – Common Work Results for Communications

B. Section 270526 – Grounding and Bonding for Communications Systems

C. Section 270528 – Pathways for Communications Systems

D. Section 271100 – Communications Equipment Room Fittings

E. Section 271300 – Communications Backbone Cabling

F. Section 271500 – Communications Horizontal Cabling

G. Section 281300 – Electronic Access Control

1.03 RESPONSIBILITIES

A. The Electrical Contractor shall be responsible for providing all equipment, cable tray, ladder rack and associated support, splices, terminating hardware, etc. as necessary to provide a functional cable support system.

B. The Electrical Contractor shall be responsible for providing all back-boxes, pull-boxes, junction boxes, conduit, and sleeves as indicated in the plans and specifications to support the low voltage systems.

C. The Electrical Contractor shall be responsible for coordinating installation with general contractor and other trades on the job to insure pathways are not impeding other system installations.

D. The term Electrical Contractor as used in this document refers to the company, group, or individual that has contract responsibility for implementing the terms and directives used in this specification document to produce the finished product as described here-in.

E. Demolition and removal of all surveillance devices and cabling shall be responsibility of the General Contractor. In areas adjacent to working (to remain) surveillance and other low voltage communications systems it shall be the responsibility of the General Contractor to maintain the integrity of the working systems which may include contracting with an authorized low voltage contractor to complete the demolition. Repairing any working low voltage communications systems damaged during demolition shall be the responsibility of the General Contractor and shall be completed at no cost to the Owner.

F. The Low Voltage Contractor for this project shall be contracted by the General Contractor/ Electrical Contractor.

1.04 SUMMARY

A. Section includes a video surveillance system consisting of cameras, video transmission cabling and data transmission cabling with all associated equipment.

B. Video surveillance system shall be integrated with existing monitoring and control system.

1.05 DEFINITIONS

A. AGC: Automatic gain control.

B. BNC: Bayonet Neill-Concelman - type of connector.

C. B/W: Black and white.

D. CCD: Charge-coupled device.

E. FTP: File transfer protocol.

F. IP: Internet protocol.

G. LAN: Local area network.

H. MPEG: Moving picture experts group.

I. NTSC: National Television System Committee.

J. PC: Personal computer.

K. PTZ: Pan-tilt-zoom.

L. RAID: Redundant array of independent disks.

M. TCP: Transmission control protocol - connects hosts on the Internet.

N. UPS: Uninterruptible power supply.

O. WAN: Wide area network.

1.06 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic even.

1.07 SUBMITTALS

A. Refer to Division 01, “General Requirements” and Section 270500, “Common Work Results for Communications” for general Submittal information and requirements.

B. Action Submittals
   1. Product Data: For each type of product indicated. Include dimensions and data on features, performance, electrical characteristics, ratings, and finishes.
   2. Shop Drawings: For video surveillance. Include plans, elevations, sections, details, and attachments to other work.
      a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
      b. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
      c. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
      d. UPS: Sizing calculations.
      e. Wiring Diagrams: For power, signal, and control wiring.
   3. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and

description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

4. All submitted product sheets containing more than one product or multiple product options shall have the submitted product clearly identified for review with all options highlight as intended for review.

C. Informational Submittals

1. Seismic Qualification Certificates: For video surveillance, cameras, camera-supporting equipment, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
2. Warranty: All required Warranty information.

1.08 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NECA 1.

C. Comply with NFPA 70.

D. Electronic data exchange between video surveillance system with the access-control system shall comply with SIA TVAC.

1.09 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 1 enclosures.
3. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambient temperatures of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. Use NEMA 250, Type 3R enclosures.
4. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick. Use NEMA 250, Type 4X enclosures.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: System components subject to corrosive fumes, vapors, and salt spray. Use NEMA 250, Type 4X enclosures.
7. Security Environment: Camera housing for use in high-risk areas where surveillance equipment may be subject to physical violence.

1.10 WARRANTY

A. Refer to Division 01 for general warranty information and requirements.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras, equipment related to camera operation, control-station equipment and recording equipment that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: shall be 3 years from date of Substantial Completion.

1.11 COORDINATION

A. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 SYSTEM REQUIREMENTS

A. Video-signal format shall comply with NTSC standard, composite interlaced video.

B. Video-signal shall be IP based and comply will IP Video transmission standards.

C. All cameras shall be provided with the appropriate licenses as required to provide a fully functional system.

D. All control equipment and operator stations shall be provided with the appropriate user clients and licenses as required to provide a fully functional system.

E. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components.
   1. Provide Surge Protection at each end of all copper cables routed beyond the building envelope between CCTV camera and CCTV equipment. Refer to specification section 264313 – Surge Protective Devices for Low-Voltage Electrical Power Circuits.

2.02 CAMERAS

A. IP Camera Acceptable Manufacturers:
   1. Axis IP: Refer to drawings for exact camera types and part number.

B. Analog Camera Acceptable Manufacturers:
   1. Bosch
   2. Panasonic
   3. Pelco

2.03 NETWORK VIDEO RECORDER (NVR)

A. Network Video Recorder:
   1. Salient: Refer to drawings for exact NVR type and part number.

2.04 OPTICAL VIDEO TRANSMISSION

A. Approved Manufacturers. Refer to drawings for exact media converter types and part numbers:
   1. Transition Networks
   2. GE, Inc.
   3. IFS

2.05 POWER SUPPLIES

A. Acceptable Manufacturers. Refer to drawings for exact power supply types and part numbers:
   1. Altronix
   2. American Dynamics

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways and other elements for compliance with space allocations, installation tolerance, hazards to camera installation, and other conditions affecting installation.

B. Examine roughing-in for LAN, WAN, and IP network before device installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 WIRING

A. Comply with requirements in Section 270528, “Communications Raceway Systems”.

B. Comply with requirements in Section 271500. “Communications Horizontal Cabling”.

C. Wiring Method: Install cables in conduit unless otherwise indicated.
   1. Except raceways are not required in accessible indoor ceiling spaces and attics.
   2. Except raceways are not required in hollow gypsum board partitions.
   3. Conceal raceways and wiring except in unfinished spaces.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

E. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

F. For copper LAN connections and fiber-optic communication wiring, comply with Section 271500. “Communications Horizontal Cabling” and Section 271300, “Communications Backbone Cabling”.

3.03 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras level and plumb.

B. Install cameras with 84-inch- minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install power supplies and other auxiliary components at control stations unless otherwise indicated.

E. Avoid ground loops by making ground connections only at the control station.

F. Identify system components, wiring, cabling, and terminals according to Section 260553, "Identification for Electrical Systems."

G. Provide surge protection at each exterior mounted camera’s signal, control, and power input. Provide surge protection at each interior termination for all exterior camera signal, control and power cables.

H. The contractor shall be responsible for all system programing as to provide the owner with a fully functional system per the owner’s operational requirements. Coordinate exact requirements with owner’s representative prior to installation.

3.04 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. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
   2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
      a. Prepare equipment list described in "Submittals" Article.
      b. Verify operation of auto-iris lenses.
      c. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
      d. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
      e. Set and name all preset positions; consult and coordinate with Owner's personnel.
      f. Set sensitivity of motion detection.
      g. Set window blanking.
      h. Connect and verify responses to alarms.
      i. Verify operation of control-station equipment.
   3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
   4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

C. Video surveillance system will be considered defective if it does not pass tests and inspections. Refer to Division 01 Section “Quality Requirements” for retesting and reinspecting requirements and Division 01 Section “Execution” for Requirements for correcting the work.

D. Prepare test and inspection reports.

3.05 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to 2 visits to Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
   1. Check cable connections.
   2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
   3. Adjust all preset positions; consult Owner's personnel.
   4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
   5. Provide a written report of adjustments and recommendations.

3.06 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

3.07 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain video-surveillance equipment.

END OF SECTION

SECTION 312200

GRADING

PART 1 - GENERAL

1.01 SUMMARY

A. All grading should conform to the guidelines presented in Appendix J of the California Building code, the minimum requirements of the City of San Diego and the recommendations of the Geotechnical Investigation completed specifically for this project. Prior to grading, a representative of the Geotechnical Engineering firm shall be present at the pre-construction meeting to provide additional grading guidelines and if necessary to review the earthwork schedule.

B. This section includes requirements for grading of the project including: excavating, preparing areas to be filled, placing, spreading, and compacting suitable fill materials, remedial grading, field survey, finish grading, and all other work necessary to conform with lines, grades, and slopes shown on the Drawings, as specified herein, and as needed for complete and proper excavation and grading operations.

C. The trenching of utilities will commence upon completion of the rough grading operation and will be in accordance with Section 312333, Trenching, Excavation, Backfilling, and Compacting.

D. During the excavation the soil will be evaluated for reuse by the Geotechnical Consultant.

E. The excess suitable material shall be hauled offsite and properly disposed of at the contractor's expense.

F. Provide all labor, material, tools and equipment necessary for site grading.

G. The engineer makes no representation that the survey information is complete or that it addresses every site condition, which may be significant to the proposed work. The provision of the survey information by the contract documents does not relieve the contractor of the responsibility to carefully examine the site and to take into account any conditions or variance with or in addition to the conditions shown on the survey. The contractor shall notify the owner prior to clearing, grubbing, grading or other ground disturbance if any such conditions or variance exist

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 024100 - DEMOLTION

B. Section 024113 – SITE CLEARING

C. Section 312333 - TRENCHING, EXCAVATION, BACKFILLING and COMPACTING

D. Section 017000 – CONSTRUCTION PROCEDURES

E. Section 015000 – Temporary Facilities and Services

1.03 REFERENCE STANDARDS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

B. Standard Specifications
   1. Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including the Regional Supplement.

C. Standard Drawings
   1. San Diego Regional Standard Drawings (2012).

D. American Society for Testing and Materials, referred to hereinafter as ASTM.

E. Geotechnical Report:
   1. A Geotechnical Report has been prepared for this project and is available for the Contractor's review. The Geotechnical Report is entitled Preliminary Geotechnical Investigation and Site Response Analysis, SeaWorld 2020 Project, SeaWorld Entertainment Park, 500 Sea World Drive, San Diego, California Prepared by Christian Wheeler Engineering, Dated February 22, 2019, (Their Project No. CWE-2180658.01)
   2. The Geotechnical Report is believed accurate, however, neither the information contained therein, nor conditions indicated to exist at the test hole locations or other site locations is guaranteed to prevail throughout the job site.

1.04 SUBMITTALS

A. Submit representative samples of material proposed for use as compacted fill for testing and approval prior to incorporation into the work of this Section.

1.05 QUALITY ASSURANCE

A. Testing
   1. Soils testing for engineering control of the grading will be under the direction of the Geotechnical Engineer. Grading shall be subject to field observation and testing.
   2. Owner will retain the services of a Geotechnical Consultant/Testing firm. The Geotechnical Consultant will be afforded the opportunity to test representative samples in accordance with 3.01.A.3 of this section. Tests and inspection costs will be incurred by the Contractor.
   3. The Geotechnical Consultant and the Environmental Monitor shall be afforded the opportunity to take soil samples, monitor soil condition, and perform soil tests without interference from Contractor's forces and equipment.
   4. The Geotechnical Consultant will advise Contractor if test results indicate unsatisfactory fill material or that the dry density of any layer of fill or portion thereof is below the specified dry density.

B. Certification: Upon completion of the Work, Contractor shall certify in writing that earthwork was performed in accordance with these Specifications, Soil’s Report recommendations, and as shown on Drawings.

1.06 PERMITS

A. Contractor shall comply with all permitting requirements of the regulatory water resource control agency during construction.
   1. California State Water Resources Control Board.

B. Contractor shall maintain a copy of all permits on-site and available for review by any regulatory agency as required, throughout the course of the work.

1.07 START OF WORK

A. Prior to initiating grading operations, field survey and stake the limits of construction.

B. Obtain the Owner's Project Manager's approval of the field survey.

C. Locate and inspect all existing on-site utilities.

D. Install all silt fences, hay bales and environmental fence along the limits of construction as indicated on the Drawings.

E. Obtain approval of proposed dewatering, erosion, sedimentation control measures and discharge

procedures of storm water runoff from Owner and regional water resources control agencies.

F. Initiate grading operations.

1.08 SITE INSPECTION AND LOCATION OF EXISTING ON-SITE UTILITIES:

A. Prior to all work of this Section, carefully inspect the entire site and all existing items to be demolished and removed or to be left intact, and determine an orderly sequence for the performance of this work. Exact locations and alignment of existing buried utility lines are not known. Locate all existing utility lines and determine the requirements for disconnection and capping. Locate all active utilities traversing the area of work to be retained and determine the requirements for protection.

B. Locate all overhead utilities and powerlines and determine height restrictions. Do not operate equipment in the vicinity of overhead utilities and powerlines which may create a safety hazard.

C. Disconnection and protection of utilities: Preserve in operating condition all active utilities traversing the site and servicing adjacent structures. Protect all property including, but not necessarily limited to mains, manholes, catch basins, valve boxes, poles, guys, and other appurtenances.

1.09 PROTECTION

A. The contractor shall take precautionary measures to protect any existing facilities shown on the drawings, and any other which is not of record or not shown on the drawings.

B. Protection and Restoration of Surface: Protect newly graded areas from traffic, erosion, and settlements. Repair and re-establish damaged or eroded slopes, elevations or grades and restore surface construction prior to acceptance. Provide erosion control to prevent water-borne soil from leaving the site using appropriate measures. The contractor shall be responsible to clean up any soil deposited beyond the project limits. The contractor shall be responsible to protect storm drain catch basins using appropriate measures and to prevent sediment from entering the storm drain system during construction.

C. Protection of Existing Improvements and Facilities: All surface and sub-surface existing improvements and facilities within the project limits which are to remain in place shall be protected from damage from Contractor operation, in accordance with the General Conditions and Contract Documents.

1. If such existing improvements and facilities within the project limits are damaged by reason of the Contractor's operation, they shall be replaced, reinstalled or reconstructed at no additional cost to the Owner.

D. All site construction activities shall be conducted in such a manner as so conform to the guidelines included in the Pollution Prevention Plan for this Project. Refer to Section 017000.

1.10 SAFETY DURING CONSTRUCTION

A. The Contractor shall assume sole and complete responsibility for job site conditions during the course of construction of the project, including safety of all persons and property. This requirement shall be made to apply continuously and not be limited to normal working hours. Refer to Division 1 for additional requirements.

B. Where pedestrian and driver safety is endangered in the work of demolition and removal, and disposal of work, including protecting and restoring existing improvements, use traffic barriers with flashing lights and other approved safety devices. Refer to Section 015000. Notify the Engineer prior to beginning any such work.

C. Comply with all applicable federal, state, and local hauling and disposal regulations.

PART 2 - PRODUCTS

2.01 FILL MATERIALS

A. In general, the soil generated during on-site excavations is suitable for reuse as fill and will be evaluated for suitability during the grading operation by the Geotechnical Consultant and the Environmental Monitor.

PART 3 - EXECUTION

3.01 SITE CONDITIONS

A. General
   1. Protect features, facilities, or items shown or designated on Drawings to remain.
   2. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If a marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, in kind, at no additional cost to the Owner.
   3. Prior to commencement of grading, a Geotechnical consultant (Consultant) will be employed for the purpose of observing earthwork procedures and testing the fills for substantial conformance with the recommendations of the Geotechnical Report and these specifications. The Consultant will provide adequate testing and observations services so that they may assess whether, in their opinion, the work is being performed in substantial conformance with these specifications. It shall be the responsibility of the Contractor to assist the Consultant and keep them apprised of work schedules and changes so that personnel may be scheduled accordingly.
   4. Perform all excavations in accordance with the contract specifications and in conformance with Section 300-2 of the SSPWC and as prescribed in this section.
   5. Perform all on site fill in accordance with the contract specifications and in conformance with Section 300-4 of the SSPWC and as prescribed in this section.
   6. Comply with all applicable Federal, State, and local hauling and disposal regulations, and air pollution and environmental regulations.
   7. Comply with all applicable traffic control requirements required by the Sea World Entertainment and the City of San Diego.
   8. After the major construction operations have been completed, the Contractor shall repair and clean staging and stockpile areas to match pre-construction condition.

B. Discrepancies
   1. Verify existing grades and dimensions before starting grading operations. Notify the Engineer of Record if any discrepancy exists.
   2. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 CLEARING AND REMOVAL

A. For initial site preparation, refer to Section 024113 – Site Clearing and Section 024100 – Demolition.

3.03 EXCAVATION

A. Make all cuts in long uniform passes using appropriate equipment.

B. Edges of cut areas shall be benched so that the resulting overall slope does not exceed 2 horizontal and 1 vertical.

C. The Contractor's design and installation of vertical trenching, and/or shoring shall be consistent with the rules, orders, and regulations of CAL-OSHA and designed by a registered engineer, in the State of California.

D. Excavate existing material to plan and depth locations shown on drawings, and as described in the Soils Report. All bottoms of excavated surfaces shall be free of ruts, hummocks, and other

uneven surface features.

E. All excavated surfaces shall be approved by the Geotechnical Consultant prior to proceeding with scarification and compaction, and prior to proceeding with fill placement.

F. Temporary stockpiling of the suitable soil that is cleared by the Engineer for reuse consists of the work involved to temporarily place the soil prior to reuse for the project with the location determined by the District and the Contractor.

3.04 UNSUITABLE OR EXCESS SOILS

A. Contractor shall manage geotechnically unsuitable, environmentally unsuitable, and excess soil that is suitable for reuse.

3.05 PLACING, SPREADING, AND COMPACTING FILL MATERIAL

A. Compact fill material near to slightly over optimum moisture conditions using equipment that is capable of producing a compacted product.

B. Prior to placing hardscape base materials within proposed pavement and exterior flatwork improvement areas, the upper twelve (12) inches of the subgrade soil shall be scarified, moisture conditioned as necessary, and recompacted to a dry density of at least 95% of the laboratory maximum dry density near to slightly above the optimum moisture content as determined by ASTM D 1557 and per the Soils Report.

C. Permanent slopes shall be inclined no steeper than 2:1 (horizontal to vertical). Fills over sloping ground shall be constructed in accordance with the recommendations of the Geotechnical Consultant.

D. The Contractor shall examine all areas designated to receive fill materials and shall immediately report in writing any condition that in his opinion, prevents the proper placement of the specified materials. Placement of the materials shall not be started until the contractor has received directions from the Owner's Representative and Geotechnical Consultant concerning any necessary corrections of the condition.

3.06 FINISH GRADING

A. The finish grading operation will commence after completion of the utility trenching and backfill and will consist of completing the excavation, placement, spreading, and compacting of the existing suitable soil to the subgrade elevations for pavement and hardscape improvements and the final grade elevations of the bioretention basins, landscaped areas, and slopes as shown on the approved drawings to the tolerances as specified in these Specifications.

B. The suitable soil for reuse shall be placed, spread and compacted as specified in the Preliminary Geotechnical Investigation and Site Response Analysis, SeaWorld 2020 Project, SeaWorld Entertainment Park, 500 Sea World Drive, San Diego, California Prepared by Christian Wheeler Engineering, Dated February 22, 2019, (Their Project No. CWE-2180658.01)

C. Payment for finish grading shall be included in the contract price paid for Earthworks, listed in the Bid Schedule, and no additional compensation will be allowed therefore.

3.07 OBSERVATION OF GRADING OPERATIONS

A. Geotechnical Consultant
   1. The Geotechnical Consultant will be the Owner's representative to observe and perform tests during clearing, grubbing, filling, and compaction operations.
   2. The Geotechnical Consultant will perform a sufficient distribution of field density tests of the compacted soil or soil-rock fill to provide a basis for expressing an opinion whether the fill material is compacted as specified.

3.08 PROTECTION OF WORK

A. During Grading
   1. Grade the site to provide positive drainage away from structures and to prevent water from ponding adjacent to structures. Water shall not be allowed to damage adjacent properties or finished work on the site. Positive drainage shall be maintained until permanent drainage and erosion control facilities are installed in accordance with project Drawings.
   2. Construct temporary ditches and siltation basins, as required, to prevent runoff of silt and debris off the site and erosion downstream of the site.

3.09 MAINTENANCE

A. After grading operations have been completed, maintain all excavated and filled areas until such time that the project is complete and accepted for maintenance by Sea World Entertainment.

PART 4 - MEASUREMENT AND PAYMENT

4.01 Full compensation for work that is specified, shown on the drawings, or required per the contract without a specific bid item listed for such work shall be included in the prices paid for various corresponding contract items of work in the bid schedule and no additional compensation will be allowed therefore.

4.02 PAYMENT

Payment shall be determined using the unit price and the quantity installed. The estimated bid quantity is for the purpose of establishing a Contract unit price for this item and the Owner reserves the right to adjust the actual quantity to 25% to 150% of the bid quantity at no change to the Contract unit price. Actual quantities for Payment should be diligently recorded.

END OF SECTION

SECTION 312319

DEWATERING (DURING CONSTRUCTION)

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope of Work: The work to be performed under this Section shall include the design and installation of a temporary dewatering system to be used until completion of construction. The system shall be designed to remove subsurface waters from structure or utility trench excavations as required.

1.02 RELATED SECTIONS

A. Section 024113: Site Clearing

B. Division 31: Earthwork

C. Division 31: Grading

D. Division 31: Fill and Backfill

E. Division 31: Trenching for Site Utilities

F. Division 33: Subdrainage

1.03 SUBMITTALS

A. Submit to the Owner or Owner's Representative for review, four copies of the proposed dewatering system. The Owner's review shall be for method only. The Contractor shall remain responsible for the adequacy and safety of the methods.

B. Submittals shall include the following:
   1. Design notes and drawings.
   2. Descriptive literature of the proposed temporary dewatering system.
   3. Layout of all piping involved.
   4. Observation well locations.
   5. Completed Water Management District dewatering permit application.

C. All submittal data shall be found in three-ring binders and all sections shall be tabbed and properly indexed.

1.04 QUALITY ASSURANCE

A. Qualifications: The temporary dewatering system proposed for use on this project shall be designed by a firm that regularly engages in the design of dewatering systems and that is fully experienced, reputable and qualified in the design of such dewatering systems. The firm shall have a successful record of operation of such systems for a minimum of five (5) years prior to bid date. The design firm shall supply the Owner with previous installation details of at least (3) successful dewatering operations of a similar nature in the project's jurisdiction.

B. Standards: The dewatering of any utility structure, drainage structure, or utility trench and the disposal of water during construction shall be in strict accordance with all local and state government rules, regulations, and permit conditions.

1.05 PERMITS

A. The Contractor shall be responsible for the preparation of, submission of, costs for, and any additional requirements (including permit compliance) necessary to obtain all groundwater permits, if required.

B. When short-term dewatering activities take place, the governing Water Management District requires notification to ensure that the dewatering volumes and durations fall within their “No Notice” classification. It is the responsibility of the Contractor to provide the following information to the Owner for submittal to the appropriate agencies:
   1. Site sketch/location map;
   2. Location, number and size of pumps;
   3. Maximum dewatering volume per day;
   4. Average dewatering volume per day;
   5. Total dewatering volume for the dewatering activity/project;
   6. Estimated start and finish dates or total days of dewatering.

1.06 JOB CONDITIONS

A. Test borings made on the site and the sub-surface exploration data are separately bound and provided upon request with each set of Contract Documents and are for the Contractor's information ONLY.

1.07 OBSERVATION WELLS

A. Prior to excavation, the Contractor shall install groundwater observation wells at locations to be approved by the Engineer adjacent to structures under construction for the purpose of measuring water levels during excavation. The observation well shall consist of screen, casing and cap of approved size and material of construction. The observation well shall be placed in a 2-1/2-inch bore hole which shall be carried to an elevation at least to final bottom grade of structure. The annular space surrounding the intake point and the riser pipe shall be sealed in such a way as to prevent infiltration from surface water. The observation well shall be developed in such a manner as to ensure proper indication of subsurface water levels adjacent to the well.

B. The Contractor shall be responsible for maintaining the observation wells and for observing and recording the elevation of groundwater in them until adjacent structure is completed and backfilled. Each observation well shall be observed and recorded daily. Measurements shall be supplied daily to the Engineer. The Engineer may require that the observation wells reflect true groundwater levels by adding water to the well, recording the drop in the level from the time the water was added. A plugged observation well shall be redeveloped as necessary to indicate true groundwater levels.

C. Observation wells shall be abandoned when directed by the Engineer, and in a manner acceptable to the Engineer.

PART 2 - PRODUCTS

2.01 GENERAL

A. The equipment shall be standard dewatering equipment of proven ability as designed, manufactured, and installed by firms having experience in the design and production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practices and methods.

B. The Contractor shall submit a conceptual plan for the dewatering system prior to commencing work. Dewatering system shall be designed in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at the proposed structures or utilities and to preserve the integrity of any adjacent structures.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Dewatering: The Contractor shall install a temporary dewatering system for the removal of subsurface water encountered during construction of the proposed structures or excavation of

utility trenches (Division 31-Fill and Backfill, Trenching for Site Utilities, and Division 33-Subdrainage).

3.02 PUMPING AND DRAINAGE

A. The Contractor shall at all times during construction provide and maintain proper equipment and facilities to remove all water entering the proposed excavations. The Contractor shall keep such excavations dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fills, structures or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels. The Contractor shall submit to the Owner, for review, a plan for dewatering systems prior to commencing work.

B. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing of the subgrade soils at proposed bottom of excavation and to preserve the integrity of adjacent structures. At a minimum, the water level shall be 2 feet below the trench or excavation bottom. Well and/or pump installations shall be constructed with proper sand filters to prevent drawing of finer grained soil from the surrounding ground.

C. Surface water that could potentially enter the excavation shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and pumped from the area of the excavation to maintain a bottom free from standing water.

D. The Contractor shall take all additional precautions to prevent uplift of any structure during construction.

E. Flotation shall be prevented by the Contractor by maintaining a positive and continuous operation of the dewatering system. The Contractor shall be fully responsible and liable for all damages which may result from failure of this system.

F. The Contractor shall take all necessary precautions to preclude the accidental discharge of fuel, oil, etc. in order to prevent adverse effects on groundwater quality.

3.03 PROTECTION AND SITE CLEAN-UP

A. At all times during the progress of the work the Contractor shall use all reasonable precautions to prevent either tampering with the temporary dewatering system or the entrance of foreign material into the existing storm drain system.

B. Immediately upon completion of the dewatering operations, the Contractor shall remove all of his equipment, materials, and supplies from the site of the work, remove all surplus materials and debris, fill in all holes or excavations, and grade the site to elevations of the surface levels which existed before work started.

3.04 DISCHARGE

A. All dewatering discharges must be conveyed to spreader swales located a minimum of 50 feet upland of the point of discharge. Discharge from the spreader swale is overland flow through a minimum of 50-feet-long/wide natural, undisturbed area prior to discharge into the adjacent wetlands or canals.

B. The water quality of dewatering discharge shall meet the governing Water Management District, state Department of Environmental Protection, Environmental Protection Agency, and from city and county agencies.

END OF SECTION

SECTION 312333

TRENCHING, EXCAVATION, BACKFILLING, AND COMPACTING

PART 1 - GENERAL

1.01 SUMMARY

A. The scope of work includes all labor, materials, tools, equipment and incidentals necessary to construct utility trenches including backfill materials, testing, trench excavation, backfill and compaction and shoring for utility piping and structures, and all incidental work, as necessary to complete Contract work as shown on the drawings and as specified in these Special Provisions.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 312200 – Grading

B. Section 312319 – Dewatering During Construction

C. Section 024113 – Site Clearing

1.03 REFERENCE STANDARDS

A. Standard Specifications
   1. Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including the Regional Supplement.

B. Standard Drawings
   1. San Diego Regional Standard Drawings (2012).

C. Current American Society for Testing and Materials, referred to hereinafter as ASTM.
   1. ASTM D 75 - Practice for Sampling Aggregates
   2. ASTM D 1556 - Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
   3. ASTM D 1557- Test Method for Moisture-Density Relations of Soils Using a Modified Effort
   4. ASTM D 2419 - Test Method for Sand Equivalent Values of Soil and Fine Aggregate
   5. ASTM D 6938 - Test Method for Density of Soil in Place by Nuclear Methods (Shallow Depth)
   6. ASTM D 3017 - Test Method for Water Content of Soil and Rock in Place by Nuclear Methods
   7. ASTM D 3776 - Test Method for Mass Per Unit Area (Weight) of Woven Fabric

D. California Occupational Safety and Health (CAL-OSHA)
   1. Title 8 General Industry Safety Orders

1.04 SUBMITTALS

A. Submit representative samples of material proposed for use as backfill material for testing and approval prior to the start of work of this section to the Geotechnical Engineer of Record

1.05 GEOTECHNICAL TESTING

A. The Owner will engage the services of a geotechnical engineering firm or individual licensed in the State of California to monitor soil conditions during earthwork, trenching, bedding, backfill and compaction operations. Sampling and testing procedures shall be performed in accordance with the Reference Standards and as follows:

B. The soils technician shall be present at the site during all backfill and compaction operations. Failure to have the soils technician present will subject such operations to rejection.

C. A report of all soils tests performed will be stamped and signed by the soils firm or individual and will be submitted by the Contractor prior to the filing of the Notice of Completion. The report will document the sampling and testing of materials, the location and results of all tests performed, and will certify that materials and work are in compliance with this specification.

1.06 PROTECTION OF EXISTING UTILITIES AND FACILITIES

A. The Contractor shall be responsible for the care and protection of all existing utilities, facilities and structures that may be encountered in or near the area of the work in the Contract Documents and General Conditions.

1.07 PROTECTION OF EXISTING LANDSCAPING

A. The Contractor shall be responsible for the protection of all trees, shrubs, fences, and other landscape items adjacent to or within the work area in accordance with Section 024113 – Site Clearing.

1.08 CHANGES IN LINE AND GRADE

A. In the event obstructions not shown on the plans are encountered during the progress of the work, and which will require alterations to the plans, the Contractor shall notify the Owner/District and Engineer. The Contractor shall not deviate from the specified line and grade without prior written approval by the Owner and/or Engineer.

PART 2 - MATERIALS

2.01 GENERAL

A. The Contractor shall furnish bedding and backfill material as specified by the San Diego Regional Standard Drawings, and Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including the Regional Supplement.

B. The Contractor shall request inspection from Geotechnical Engineer of Records of stockpiled materials, and receive confirmation that materials are adequate prior to reuse in trench bedding and backfill applications,

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall trench, and install bedding and shoring, and backfill material, and mechanically compact backfill as specified by the San Diego Regional Standard Drawings, and Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including the Regional Supplement.

B. The trench bottom shall be graded to provide a smooth, firm, and stable foundation that is free from rocks and other obstructions

3.02 DEWATERING

A. Though groundwater is not anticipated per the current soils report, dewatering of the soil shall be executed per 312319, and included in the bid item for each applicable bid item.

3.03 COMPACTION REQUIREMENTS

A. Compaction shall be accomplished by mechanical means, in compliance with the soils report, and to the satisfaction of the Geotechnical Engineer.

B. If the backfill fails to meet the specified relative compaction requirements; the backfill shall be reworked until the requirements are met. All necessary excavations for density tests shall be made as directed by the Geotechnical Engineer, and as acceptable to the District. The requirements of the Agency having jurisdiction shall prevail on all public roads.

C. All backfilled excavations are subject to compaction tests.

PART 4 - MEASUREMENT AND PAYMENT

4.01 Full compensation for work that is specified, shown on the drawings, or required per the contract without a specific bid item listed for such work shall be included in the prices paid for various corresponding contract items of work in the bid schedule and no additional compensation will be allowed therefore.

END OF SECTION

SECTION 313100

SOIL TREATMENT / TERMITE CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Subterranean termite prevention treatment of soil areas scheduled to receive new construction, including:
   1. Soil beneath slabs on grade.
   2. Soil adjacent to shallow footings.
   3. Soil adjacent to foundation walls.
   4. Soil adjacent to foundations for columns, and other structures.
   5. Subterranean termite prevention treatment of new construction in progress.

1.02 SUBMITTALS

A. Product Data: Submit product label or accompanying labeling in accordance with the Federal Insecticide, Fungicide, and Rodenticide Act and showing:
   1. Ingredient statement.
   2. Indications for use.
   3. Limitations of use and contraindications.
   4. Estimated duration of efficacy or recommended frequency of reapplications.
   5. Environmental Protection Agency registration number.

B. Quality Control Submittals:
   1. Certificates: Evidence of installer's authorization to apply products under applicable state and local law.
   2. Manufacturer's instructions: Submit manufacturer's directions for use.

C. Contract Closeout Submittals:
   1. Project record documents
      a. Submit a certificate signed by installer and contractor stating that treatment has been applied in accordance with applicable governing regulations and in accordance with this specification.
      b. Incorporate into the certificate or attach thereto a plan drawing indicating actual application locations and, for each location, noting methods and rates of application and including typical sections or details where necessary for clarity.
   2. Warranty

1.03 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Licensed to install specified products in the State of California and City of San Diego.
   2. A company installing products of this section and whose installations have performed in a satisfactory manner under comparable conditions for a period of 2 years.

B. Regulatory Requirements:
   1. Comply with Title 7, United States Code 136 through 136y – Federal Insecticide, Fungicide, and Rodenticide Act as amended 1947 (Revised 1988).
   2. Comply with applicable pesticide regulations of the State, County and City in which the project is located.
   3. Comply with applicable local pesticide regulations.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Dispense product from manufacturer's original containers, with labels intact and bearing EPA registration number. Do not store in containers other than properly labeled containers.

1.05 WARRANTY

A. Special Warranty:
   1. Submit installer's warranty against infestation of treated areas.
   2. Warranty shall not reduce or otherwise limit any other rights to correction which the owner may have under the contract documents.
   3. Warranted period: 5 years

B. Correction during the warranty period shall include not less than the following:
   1. Retreatment of areas in which evidence of infestation is discovered.
   2. Repairing, patching, removing, and reinstalling of building materials and soil materials when necessary to facilitate retreatment following infestation.
   3. Restoration, repair, or replacement of building materials (including permanent fixtures) that become damaged by subterranean termites.

PART 2 - PRODUCTS

2.01 TERMITICIDE

A. Registered with the United States Environmental Protection Agency (EPA) for use as a termiticide under conditions of use prevailing at the project site.

B. Registered with the applicable authorities in the state in which the project is located and with local governing authorities, as applicable for use as a termiticide under conditions of use prevailing at the project site.

C. Subject to compliance with requirements, provide "Termidor"; a product of the BASF Corporation.

PART 3 - EXECUTION

3.01 APPLICATION

A. Application to be made by a contractor licensed to install the specific products.

B. Apply termiticide in strict accordance with manufacturer's instructions

C. Apply termiticide at the maximum recommended application rates for the respective areas to be treated and methods of treatment used.

D. Treat the entire structure. Do not leave any portion untreated.

E. Schedule treatment of new construction to occur when treatment may be applied directly to the soils and surfaces to be treated, and prior to their concealment with subsequent construction.

3.02 CLEANING

A. Do not allow contamination of surfaces not intended to be treated. Follow manufacturer's instructions to completely remove chemical from surfaces should contamination occur.

END OF SECTION

SECTION 315000

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Requirements:
   1. Section 312000 "Earth Moving" for excavating and backfilling and for controlling surface-water runoff and ponding.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.
   1. Include plans, elevations, sections, and details.
   2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
   3. Indicate type and location of waterproofing.
   4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

1.04 INFORMATIONAL SUBMITTALS

A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

C. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.05 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others.

B. 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 a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.
   1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.
   2. The geotechnical report is included elsewhere in Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
   1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
   2. Prevent surface water from entering excavations by grading, dikes, or other means.
   3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
   4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.02 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

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 that could develop during excavation support and protection system operations.
   1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.02 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.03 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks weekly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original eleva-

tions and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.04 REMOVAL AND REPAIRS

A. Leave excavation support and protection systems permanently in place.

END OF SECTION 315000

SECTION 321216

ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY OF WORK

A. The scope of work includes all labor, materials and equipment to provide and place asphalt concrete pavement, aggregate base, furnishing mix design, spreading, compacting where shown on the Drawings, as specified herein, and as needed for the complete and proper installation.

1.02 RELATED SECTIONS

A. Section 013300 – Submittal Procedure.

B. Section 099000 - Painting and Coating: Pavement markings.

C. Division 31 - Fill and Backfill: Compacted sub-base for paving.

1.03 REFERENCE STANDARDS

A. Standard Specifications
   1. Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), Including the Regional Supplement.

B. Standard Drawings
   1. San Diego Regional Standard Drawings (2012)

C. American Society for Testing and Materials (ASTM)

1.04 DEFINITIONS

A. Geotechnical Consultant - the Geotechnical Engineering and Engineering Geology consulting firm retained by the District will provide technical services for the project. Observations by the Geotechnical Consultant include observations by the Soil Engineer, Geotechnical Engineer, Engineering Geologist and those performed by persons employed by and responsible to the Geotechnical Consultant.

B. Finish Grade - the ground surface configuration at which time the surface elevations conform to the approved Drawings.

1.05 SUBMITTALS

A. Materials List: Submit complete list of all proposed materials. Identify material source, quality, and characteristics.

B. Mix Designs: Accompanying the materials list, submit proposed asphalt concrete mix designs, including aggregate gradation, asphalt content, and asphalt type for the various types of work specified to the District for review and approval.

1.06 PRODUCT HANDLING

A. Protection
   1. Deliver, store and handle all products in a manner to prevent damage and deterioration.
   2. Use all means necessary to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

PART 2 - MATERIALS

2.01 ASPHALT CONCRETE

A. Asphalt concrete pavement shall conform to the requirements of Section 203-6, “ASPHALT CONCRETE” of the SPPWC and Regional supplement.

2.02 AGGREGATE BASE

A. Aggregate base shall conform to the requirements of Section 200-2, “UNTREATED BASE MATERIALS” of the SPPWC and Regional Supplement.

PART 3 - EXECUTION

3.01 VERIFICATION OF CONDITIONS

A. Inspection
   1. Prior to performing the work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where work may properly commence.

B. Discrepancies
   1. In the event of discrepancy, immediately notify the Engineer.
   2. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

C. Acceptance of Surface Conditions
   1. Provide Engineer with written acceptance of surface conditions, certifying that all surfaces are suitable for work of this Section to proceed.

3.02 PREPARATION

A. Prepare subgrade for placement of asphalt concrete as specified in the SSPWC, and per the Geotechnical Report.

B. Base Course
   1. Place, spread, and compact aggregate base in conformance with Section 301-2, “UNTREATED BASE” of the SPPWC and Regional Supplement.
   2. Each layer of base course shall be tested and approved by the testing laboratory prior to the placement of successive layers.
   3. Compacted base thickness shall be as indicated on Drawings, or as determined in the field by the Geotechnical Engineer.

C. Asphalt Concrete Surfacing
   1. 1Conform to the applicable portions of Section 302-5, "Asphalt Concrete Pavement," of the SSPWC and Regional Supplement.
   2. No paving course shall be placed when the atmospheric temperature is below 50 degrees F.
   3. The pavement surface, when completed, shall be smooth, dense, well bonded, and of uniform texture and appearance.
   4. Pavement compacted thickness shall be flush with adjacent surface.
   5. All areas shall drain and be free of standing water.
   6. Compacted thickness of paving shall be as indicated on Drawings, as specified or as determined in the field by the Geotechnical Engineer.

END OF SECTION

SECTION 321300

CONCRETE PAVING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Formwork for pavements, curbs, site stairs and site ramps.

B. Formwork accessories.

C. Form stripping.

D. Reinforcing steel and accessories.

E. Cast-in-place concrete for pavements, curbs, site stairs and site ramps.

F. Broom Finish for Pavements

G. Concrete staining.

H. Joint Fillers/Sealants/Backer.

I. Concrete curing.

J. Concrete sealing.

K. Quality assurance surveys of form work and in-place concrete.

1.02 RELATED SECTIONS

A. Section 033000 - Cast-in-Place Concrete.

B. Section 055213 – Metal Pipe and Tube Railings: At site stairs and ramps.

C. Section 079200 - Joint Sealants: Sealant for joints.

D. Section 099000 - Painting and Coating: Pavement markings.

E. Division 31 - Fill and Backfill: Compacted sub-base for paving.

F. Division 32 - Manholes and Covers: Manholes including frames.

1.03 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International.

C. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International.

D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International.

E. ACI 305R - Hot Weather Concreting; American Concrete Institute International.

F. ACI 306R - Cold Weather Concreting; American Concrete Institute International.

G. ASTM A 185/A 185M - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

H. ASTM A 497/A 497M - Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.

I. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for_ Concrete Reinforcement.

J. ASTM C 33 - Standard Specification for Concrete Aggregates.

K. ASTM C 39/C 39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

L. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete.

M. ASTM C 150 - Standard Specification for Portland Cement.

N. ASTM C 173/C 173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

O. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.

P. ASTM C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

Q. ASTM C 494/C 494M - Standard Specification for Chemical Admixtures for Concrete.

R. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

S. ASTM C 685/C 685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.

T. ASTM D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (non-extruding and Resilient Bituminous Types).

U. ASTM D 1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

V. ASTM F 1679 - Standard Test Method for Using a Variable Incidence Tribometer (VIT).

1.04 SUBMITTALS

A. Submit certifications of survey work as required by Division 1.

B. Product Data: Submit manufacturer's product data for the following:
   1. Concrete ingredients.
   2. Concrete admixtures.
   3. Color admixture.
   4. Dry shake colored hardener/antiquing release.
   5. Bond-breaker for imprinting tools.
   6. Concrete staining.
   7. Joint filler.
   8. Reinforcement and accessories.
   9. Exposed aggregate.
   10. Concrete curing.
   11. Concrete sealing.

C. Design data: Submit proposed mix designs and test data before concrete operations begin. Identify for each mix submitted the method by which proportions have been selected.
   1. For mix designs based on trial mixtures, include trial mix proportions, test results, and graphical analysis and show required average compressive strength f(cr).
   2. Indicate quantity of each ingredient per cubic yard of concrete.
   3. Indicate type and quantity of admixtures proposed or required.

D. Shop Drawings: Submit shop drawings for fabrication, bending and placement of concrete reinforcement and bar supports. Comply with the SP-66.

1. Shop drawings shall indicate location of construction, contraction, and isolation joints.

E. Delivery tickets: Submit copies of delivery tickets complying with ASTM C 94 for each load of concrete delivered to site, with placement location noted.

F. Hot weather and/or cold weather concreting: Submit description of planned protective measures.

G. Mill Certificates: submit steel producer's certificates of mill analysis, tensile and bend tests for reinforcing steel.

H. Materials Certificates: Provide materials certificates in lieu of materials laboratory test reports only when permitted by the Owner's Project Manager. Material certificates shall be signed by the materials producer and the Contractor, certifying that each material item complies with, or exceeds, the specified requirements.

I. Certification by Tool-imprinting manufacturer that Contractor is licensed to install and finish their concrete finishing system.

J. Operations Manual: Sufficiently in advance of concrete placement to allow a thorough review, submit to the Owner's Project Manager the following information, bound in the form of a manual:
   1. Design mixes and test results for each classification of concrete, including brand names of cement and admixtures, and source and type of aggregates.
   2. Drawing showing contraction, construction and isolation joint locations and pour sequence and elapsed time between pours for each classification of concrete.
   3. For each pour sequence, the method of placement. When a pump mix is submitted, indicate the design slump of the as-delivered concrete and the anticipated slump at the point of placement.
   4. For each pour sequence, the method of curing the concrete. For wet cures, indicate the method. For curing compounds, submit manufacturer's instructions for application.
   5. Method of achieving tool imprinted special finishes as called for.
   6. Type and brand name of sealants to be used.
   7. Exposed aggregate finishing process.
   8. Seeded rock salt finishing process.
   9. Concrete staining methods and products.

K. Maintain a copy of the Approved Operations Manual in the field office at all times.
   1. No deviations will be allowed from products and procedures outlined in the Approved Operations Manual, except when permission is requested in writing and approval for same has been allowed by Owner's Project Manager.

1.05 QUALITY ASSURANCE

A. Testing Agency Services:
   1. Owner will engage testing agency to conduct tests and perform other services specified for quality control during construction.

B. Source of Materials: Obtain materials of each type from same source for the entire project.

C. Contractor shall perform survey work as required by Division 1, Section 010400 - Accessibility for Persons with Disabilities.

D. Comply with the building codes as enforced by the appropriate authorities having jurisdiction. Refer to Section 010300 for a listing of applicable codes.

E. Field Reference Manual: Have available at the project field office a copy of ACI SP-15(99) "Standard Specifications for Structural Concrete ACI 301 with Selected ACI and ASTM References" and a copy of ICRI/ACI "1999 Concrete Repair Manual."

F. Accessibility manuals as required by Division 01.

G. Design, construct, erect, maintain and remove forms for concrete formwork in compliance with ACI 347.

H. Contractor is responsible for correction of concrete work which does not conform to the specified requirements, including but not limited to strength, slump, workability, setting time, dimensional tolerances and finish. Correct deficient concrete as directed by the Owner's Project Manager.

I. Acceptable construction tolerances for dimensional envelope of pavement surfaces:
   1. Acceptable elevation variance from any given elevation: ± 1/4".
   2. Acceptable straight line variance in any 10 foot length: ± 1/4".
   3. Acceptable accumulated variance in any 40 foot length: ± 3/4".
   4. Formwork straightness tolerance: 1/8 inch in 10 feet from true plane surface along top; ¼ inch in 10 feet along face.

J. Walking surfaces shall have a 1) Static coefficient of friction (COF) per ASTM C1029-07E1 under dry conditions of a minimum of 0.6 for slopes of less than 1:21 and a minimum of 0.8 for slopes exceeding 1:21, and 2) dynamic coefficient of friction (DCOF) per ANSI 137.1-2012 Section 9.6 DCOF ACUTEST under wet conditions of not less than 0.42.

K. Contractor shall present a certificate and/or license to provide the tool-imprinted concrete finish.

L. All slab work shall be delayed as late into project schedule as practicable to reduce exposure to construction activities that may stain or damage the surface.
   1. Use care to prevent damage especially for concrete to receive stains. Remove and replace concrete damaged/stained that makes it unacceptable to the Owner's Project Manager.

1.06 MOCK-UPS

A. Before beginning the installation of pavements, Contractor shall provide jobsite samples, located as directed by the Owner, of each variation of concrete mix design and finish including, but not limited to integral color, tool-imprinted, stained, and/or exposed aggregate finishes.
   1. Provide at a minimum, 4'x 4' panels of each type of pavement to show colors, materials, finishes, and installation quality.
   2. Provide at a minimum 4' long sections of each type of concrete curb to show colors, materials, finishes, and installation quality.

B. Contractor must achieve approval of the mock-ups by the Owner prior to the start of construction.
   1. Provide additional mock-ups as required to receive Owner's approval.
   2. Rejected mock-ups and samples shall be resubmitted for approval at no additional cost to the Owner.

C. Mock-ups and samples shall not be removed until Substantial Completion of the project.
   1. Approved mock-ups shall remain intact as the standard for evaluating the completed work.

D. Approved samples may be incorporated into the finished work at the approval of the Owner.

1.07 PRE-CONSTRUCTION TESTING AND MIX DESIGN

A. Pre-Construction Material Testing Service: Employ, at Contractor's expense, a testing laboratory acceptable to Owner's Project Manager to perform material evaluation tests and to design concrete mixes and to conduct tests on laboratory trial batches for all classes of concrete. These tests are not part of on-site quality control testing, which is specified as part of Field Quality Control in this section.

B. Testing agency shall meet the requirements of ASTM E 329.

C. Materials may require testing and retesting, as directed by the Owner's Project Manager, at any time during the progress of the work. Allow free access to material stockpiles and facilities at all times. Tests, not specifically indicated to be done at Owner's expense, including the retesting of

rejected materials including installed work, shall be done at Contractor's expense.

D. Tests for Concrete Materials:
   1. Test aggregates by method of sampling and testing of ASTM C 33.
   2. For Portland cement, sample the cement and determine the properties by the methods of test ASTM C 150.
   3. Submit written reports to the Owner's Project Manager, for each sample tested, prior to the start of work. Provide the project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for intended use.

1.08 PROJECT CONDITIONS

A. Be prepared to work during off hours in areas that must remain open to park guests during park operation hours. Provide schedule of operations to Owner's Project Manager for approval. Include relocation of construction fences as necessary.
   1. This can include fence relocation, removal of existing paving, installation of paving, landscaping and replacement of fence all in time for the park to open next day on schedule.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

A. Form Materials: Conform to ACI 301.

B. Pavement Forms: Standard steel paving forms in sections not less than 10 feet in length.
   1. Single piece; depth equal to slab thickness.
   2. Base width at least three-fourths of form depth but not less than 8 inches, unless otherwise approved.
   3. Straightness tolerance: 1/8 inch in 10 feet from true plane surface along top; 1/4 inch in 10 feet along face.
   4. Locking provisions at ends of abutting form sections.
   5. Wood forms complying with the above provisions, including base and locking, may be used only where form of less than 10 feet is required.
   6. Wet screeds will not be permitted.

C. Curb Forms - Wood or Metal:
   1. Straight, no warps or bends and smooth, of sufficient length to resist pressure of concrete placement when staked.
   2. Flexible forms for circular curbs.
   3. Size of forms equal to depth of concrete.

D. Curbs - Extruded:
   1. Machine Extruded method will be allowed in parking areas, loop roads and maintenance roads provided that an acceptable finished product, true to line, grade, cross section and finish is consistently produced

2.02 REINFORCEMENT

A. Reinforcing Steel: ASTM A 615/A 615M Grade 60 (420); deformed billet steel bars; unfinished finish.

B. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcement in place.
   1. Use wire bar type supports complying with CRSI recommendations, unless otherwise indicated. Do not use wood, brick and other unacceptable materials, except as permitted

herein.

C. Welding of reinforcing bars is unacceptable.

D. Fabrication:
   1. Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI “Manual of Standard Practice” and with ACI 315. In case of fabricating errors, do not re-bend or straighten reinforcement in a manner that will injure or weaken the material.
   2. Unacceptable Materials: Reinforcement with any of the following defects will not be permitted in the work:
      a. Bar lengths, depths and bends exceeding CRSI fabrication tolerances.
      b. Bends or kinks not indicated on the Drawings or final shop drawings.
      c. Bars with cross-section reduced by excessive rusting or other causes.

E. Steel Welded Wire Reinforcement: Plain type, ASTM A 185/A 185M; in flat sheets; unfinished.

F. Load transfer devices for construction joints: Plate dowels with sleeves.
   1. Manufacturer: PNA Construction Technologies; 800-542-0214; www.pna-inc.com.
   2. Product: Diamon Dowel System; plate size of 3/8" x 4 1/2", spaced as indicated on drawings. Plate shall be galvanized steel with a Diamond Dowel Pocket Former.

G. Epoxy coated dowel bars for isolation joints where shown in drawings. ASTM A775; Plain steel bars, as specified above, cut to true lengths with ends square and free of burrs prior to coating with epoxy.

2.03 CONCRETE MATERIALS

A. Obtain cementitious materials from same source throughout.

B. Cement: ASTM C 150 Normal - Type I Portland type, grey color.

C. Aggregates:
   1. Normal weight concrete: ASTM C 33.
      a. Class 1N.
   2. Fine Aggregate:
      a. Clean, sharp, natural sand free from loam, clay, lumps, or other deleterious substances.
      b. Dune sand, bank-run sand and manufactured sand are not acceptable.
   3. Coarse Aggregates:
      a. Clean, uncoated, processed aggregate containing no clay, mud, loam or foreign matter, as follows:
         1) Crushed stone, processed from natural rock or stone.
         2) Washed gravel, either natural or crushed. Use of pit or bank run gravel is not permitted.
      b. Maximum Aggregate Size: Not larger than one-fifth of the narrowest dimension between sides of forms, one-third of the depth of slabs, nor three-fourths of the minimum clear spacing between individual reinforcing bars or bundle of bars.
   4. Local aggregates not complying with ASTM C 33 but which have shown by special test or actual service to produce concrete of adequate strength or service and durability may be used when acceptable to the Owner’s Project Manager.

D. Water: Clean, and not detrimental to concrete.

E. Air Entrainment Admixture: ASTM C 260.
   1. Acceptable Products:
      a. "Air-Mix" by Euclid Chemical Co.
      b. "Daravair" or "Darex II AEA" by W.R. Grace Co.

c. "MB-VR" or "Micro Air" by Master Builders
d. "AER" by Sika Chemical Corp.

F. Water Reducing Admixture: ASTM C 494, Type A.
1. Acceptable Products:
a. "Eucon WR-75"; by Euclid Chemical Co.
b. "WRDA Series" by W.R. Grace Co.
c. "Daracem - 55 or 65" by W.R. Grace Co.
d. "Polyheed 997" by Master Builders
e. "Plastocrete 161" by Sika Chemical Corp.

G. Water Reducing, Retarding Admixture: ASTM C 494, Type D.
1. Acceptable Products:
a. "Eucon Retarder 75" by Euclid Chemical Co.
b. "Daratard Series" by W.R. Grace Co.
c. "Pozzolith 100-XR"; by Master Builders
d. "Plastiment" by Sika Chemical Co.

H. Color Admixture for Color-Conditioned Concrete: ASTM C 494, AASHTO M 194 and ASTM C 979.
1. Basis of Design: "Admixture" by L.M. Scofield Co.; color as indicated on drawings.

I. Dry Shake Colored Hardener: ASTM C 979 for color stability.
1. Intergrind of pigments, surface conditioning and dispensing agents, and portland cement combined with graded, non slip emery (natural aluminum oxide).
2. Basis of Design: "Color Hardener" by L.M. Scofield, Co.

J. Bond Breaker for Use with Mat Type Concrete Texturing Tools:
1. Basis of Design: "Antiquing Release" by L.M. Scofield, Co.

K. Concrete Surface Sealer:
1. Coordinate and match concrete sealer with concrete color as recommended by the manufacturer.
2. Basis of Design: "Concrete Sealer" by L.M. Scofield. Co.

L. Other Acceptable manufacturers:
1. Increte Systems.
2. Bomanite Corp.
3. Substitutions: See Section 016000 - Product Requirements.

2.04 ACCESSORIES

A. Curing Compound: ASTM C 309, Type 1, Class A.
1. To be used at locations of natural color, broom finish and exposed aggregate concrete.
2. Acceptable Products:
a. "Floor Coat" or "Pliocure" by Euclid Chemical Co.
b. "Cure-N-Seal" by Master Builders.

B. Curing Compound for concrete colored with color admixture or dry shake color hardener.
1. Water based, color matched, curing and finishing compound.
2. Acceptable Product: "Lithochrome Colorwax" by L.M. Scofield.
3. Substitutions: See Section 016000 - Product Requirements.

C. Epoxy Bonding Systems: ASTM C 881; type, grade, and class as required for project conditions.
1. Products: Provide one of the following for securing dowels into adjacent existing concrete:
a. "Concresive LPL"; Master Builders, Inc.
b. "Epoxtite Binder (Code #2390)"; A. C. Horn, Inc.

c. "Sikadur 32 Hi-Mod"; Sika Corporation.
d. "Epabond"; L&M Construction Chemicals, Inc.

D. Joint Fillers/Sealants/Backer: Refer to Section 079200.

2.05 CONCRETE MIX DESIGN

A. Prepare design mixes for each type of concrete in accordance with applicable provisions of ASTM C 94. Use an independent testing facility acceptable to the Owner for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing unless otherwise acceptable to the Owner's Project Manager.

B. All concrete shall contain the specified water-reducing admixture.

C. Proportion mixes by either trial batch method or field experience method, using materials to be employed on the project for each class of concrete required, complying with ACI 211.1 for normal weight concrete, and report to the Owner's Project Manager the following:
1. Complete identification of aggregate supply source.
2. Scale weight of each aggregate.
3. Brand, plant location, type and composition of cement.
4. Brand, type and amount of each admixture.
5. Amount of water used in trial mixes.
6. Proportion of each material per cu. yd. of concrete.
7. Gross weight and yield per cu. yd. of trial mixes.
8. Measured slump.
9. Measured air content.
10. Contractor's proposed method of placement.
11. Compressive strengths developed at 7 days and 28 days, from not less than 6 test cylinders cast for each 7 and 28 day test, and for each design mix.

D. Laboratory Trial Batches:
1. Prepare test specimens in accordance with ASTM C 192 and conduct strength tests in accordance with ASTM C 39, as specified in ACI 301.
2. Establish a curve showing relationship between water-cement ratio for cement content and compressive strength, with at least 3 points representing batches which produce strengths above and below that required. Use not less than 3 specimens tested at 28 days, or at an earlier age when acceptable to the Owner's Project Manager to establish each point on the curve.

E. Submit written reports to the Owner's Project Manager of each proposed mix for each class of concrete at least 15 days prior to the start of work.

F. Do not begin concrete production until mixes have been approved by the Owner's Project Manager.

G. Adjustment to Concrete mixes: Contractor may request design mix adjustments when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the Owner and as accepted by the Owner's Project Manager. Submit laboratory test data for revised mix design and strength results for the Owner's Project Manager's acceptance before use.

H. Admixtures:
1. Use air-entraining admixture in all concrete except footings.
a. Add air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content of 5% (± 1%), as determined in accordance with ASTM C 231.
2. Use admixtures for water-reducing and set-control in strict compliance with the manufacturer's directions.

3. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.

I. Concrete Properties:
   1. Compressive Strength, when tested in accordance with ASTM C 39/C 39M at 28 days: 4,000 psi (0.2 MPa).
   2. Water-Cement Ratio: Maximum 45 percent by weight.
   3. Maximum Slump: 3 inches (75 mm) to 5 inches (125 mm).

2.06 MIXING

A. Transit Mixers: Comply with ASTM C 94/C 94M.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify compacted sub-grade is acceptable and ready to support paving and imposed loads.
   1. Sub-grade and sub-base shall be prepared prior to the start of this concrete work. Remove loose material from compacted sub-base surface and moisten immediately before placing concrete. If sub-base will not allow percolation of water, advise Owner's Project Manager to require sub-base installer to remove 6 inches of sub-base and replace with compacted crushed stone.

B. Verify gradients and elevations of base are correct.

C. During Concrete Placement: check formwork and related supports to ensure that forms are not displaced and that completed work will be within specified tolerances.

3.02 FORMING

A. Place and secure forms to correct location, dimension, profile, and gradient.

B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.

C. General: Comply with requirements of ACI 301 for formwork, and as herein specified. Contractor is responsible for design, engineering, and construction of formwork, and for its timely removal.

D. Construction: Construct and brace formwork to accurately achieve end results required by concrete documents, properly located and accurately aligned. Provide for screeds, bulkheads, anchorages, and other features shown or otherwise required.

E. Survey in-place formwork and rework where placement exceeds tolerances specified herein.

F. Provide certification of survey to Owner as required in Section 010400.

G. Release Agent: Provide field-applied form coating. Thoroughly clean and recondition formwork and reapply coating before each use.

3.03 REINFORCEMENT

A. Delivery, Storage and Handling:
   1. Deliver reinforcement to the project site bundled, tagged and marked. Use durable, permanently marked tags indicating bar size, lengths and other information corresponding to markings shown on placement diagrams.
   2. Store concrete reinforcement materials at the site to prevent damage and accumulation of dirt or excessive rust.

B. Comply with the specified codes and standards and Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement

placement and supports, and as herein specified.

C. Clean reinforcement to remove loose rust, mill scale, earth, and other materials which reduce or destroy bond with concrete.

D. Accurately position, support and secure reinforcement against displacement by construction or concrete placement operations. Locate and support reinforcing steel by use of metal chairs, as required.

E. Place reinforcement securely and tie bars and bar supports together with 16 gage black-annealed wire. Set wire so that wire ends are directed away from exposed concrete surfaces.

F. Splices: Install standard reinforcement splices by lapping ends, placing bars in contact and tying tightly with wire. Comply with requirements of ACI 315 and ACI 318 for minimum lap of spliced bars, except where longer laps are shown on the Drawings.

3.04 COLD AND HOT WEATHER CONCRETING

A. Follow recommendations of ACI 305R when concreting during hot weather.

B. Follow recommendations of ACI 306R when concreting during cold weather.

C. Do not place concrete when base surface temperature is less than 40 degrees F (4 degrees C), or surface is wet or frozen.

3.05 CONNECTING TO EXISTING CONCRETE

A. Preparation: At locations where concrete is to join existing concrete, prepare existing surface by cleaning with wire brush and applying bond breaker in accordance with manufacturer's instructions.

B. Doweled Connections: At locations where concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels, and pack solid with non-shrink epoxy grout.

C. Epoxy coating on dowels shall prevent bonding to new pour.

3.06 CONCRETE MIXING AND DELIVERING

A. Concrete may be mixed at batch plants or it may be transit-mixed as herein specified. Batch plants must comply with the requirements of ACI 304, with sufficient capacity to produce concrete in the quantities required to meet the construction schedule. All plant facilities are subject to testing laboratory inspection and acceptance of the Owner.

B. Concrete Conveying:
   1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practicable by methods which will prevent segregation and loss of concrete mix materials
   2. Use mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Erect runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water and other deleterious materials.

3.07 PLACING CONCRETE

A. Place concrete in accordance with ACI 304R.

B. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.

C. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use re-

tempered concrete. Remove rejected concrete from the project site and dispose of in a legal location.

D. Do not use consolidation equipment (vibrator) to spread concrete.

E. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation due to re-handling or flowing. Do not subject concrete to any procedure which will cause segregation.

F. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.

G. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and to corners.

H. Consolidate concrete in slabs by vibrating bridge screeds, roller pipe screeds, or other acceptable methods. Limit the time of vibrating consolidation to prevent bringing an excess of fine aggregate to the surface.

I. Bring slab surfaces to the correct level with a straightedge and strike off. Use bull floats or darbies to smooth the surface, leaving it free of high or low areas. Do not sprinkle water or cement on the plastic surface. Do not disturb the slab prior to beginning finishing operations.

J. Maintain reinforcing steel, tie wires and forms in the proper position continuously during concrete placement operations.

3.08 JOINTS

A. Align curb, gutter, and sidewalk joints.

B. Contraction Joints:
   1. Weakened-plane joints.
   2. Saw-cut joints, 3/8 inch wide by depth 1/3 into depth of slab.
   3. Reinforcing crossing perpendicular to the joints in 6” slabs shall have every other bar cut as shown on the drawings.
   4. Clean and seal joints as shown.

C. Construction joints:
   1. End-of-pour-joints.
   2. Prevent bonding of new to previous concrete pour.
   3. Reinforcing shall not cross construction joints.
   4. Provide plate dowels as shown on the drawings.
   5. Formed sealant joint, 3/8 inch wide.
   6. Clean and seal joints as shown.

D. Isolation Joints:
   1. Movement joints.
   2. One-half inch (½”) wide by full depth of slab.
   3. Joint filler with sealant at surface.
   4. Used only where pavement adjoins curbs, existing concrete slabs and/or other improvements.
      a. Provide at all points where pavement meets vertical surfaces.
      b. Provide dowels where pavement meets existing slabs as shown on drawings.

E. Curb Joints:
   1. Contraction joints either formed or sawed.
   2. Contraction joints at one half the distance of slab joints, but not more than 20 feet on center nor closer than 4 feet on center.
   3. Construction joints shall not exceed 50 feet on center.

F. Clean all joints thoroughly with air and/or brush to ensure there is no debris left in joint that could interfere with the joint movement.
   1. Use only wet saws of an approved type.
   2. Control run-off to prevent damage to adjacent slabs, other improvements and landscaping.
   3. Control dust to prevent contamination of animal areas or pools and guest and employee areas as directed by Owner's Project Manager.

3.09 FINISHING PAVEMENTS AND CURBS

A. Finishing Operations - General:
   1. Do not directly apply water to slab surface or dust with cement.
   2. Use hand or powered equipment only as recommended in ACI 302.1R.
   3. Screeding: Strike off to required grade and within surface tolerances indicated. Certify conformance to surface tolerances. Correct deficiencies while concrete is still plastic.
   4. Bull Floating: Immediately following screeding, bull float or darby before bleed water appears to eliminate ridges, fill in voids, and embed coarse aggregate. Recheck and correct surface tolerances.
   5. Do not perform subsequent finishing until excess moisture or bleed water has disappeared and concrete will support either foot pressure with less than 1/4-inch indentation or weight of power floats without damaging flatness.
   6. Final floating: Float to embed coarse aggregate, to eliminate ridges, to compact concrete, to consolidate mortar at surface, and to achieve uniform, sandy texture. Recheck and correct surface tolerances.
   7. Troweling: Trowel immediately following final floating. Apply first troweling with power trowel except in confined areas, and apply subsequent trowelings with hand trowels. Wait between trowelings to allow concrete to harden. Do not overtrowel. Begin final troweling when surface produces a ringing sound as trowel is moved over it. Consolidate concrete surface by final troweling operation. Completed surface shall be free of trowel marks, uniform in texture and appearance, and within surface tolerance specified.

B. Float Finish: Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified.

C. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently to permit the operation of a power-driven float, or both. Consolidate the surface with power-driven floats, or by hand-floating if area is small or inaccessible to power unit. Check and level the surface plane to a tolerance as specified herein.
   1. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

D. Trowel Finish: Apply trowel finish to monolithic slab surfaces, unless otherwise shown.
   1. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.
   2. Consolidate the concrete surface by the final hand troweling operation free of trowel marks, uniform in texture and appearance and with surface plane tolerance specified herein.

E. Non-Slip Broom Finish: Apply non-slip broom finish to top of slabs, ramps, curbs and also where shown on the Drawings or in schedules.
   1. Immediately after trowel finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route or in the pattern shown on the Drawings. Use fiber-bristle broom unless otherwise directed.
   2. Coordinate the required final finish with the Owner's Project Manager before application of curing membrane.
   3. Curbs shall receive straight-line soft broom finish with lines linear with the length of the

curb, parallel to the grade.

H. Concrete Curbs with Integral and/or Stained Color:
   1. Integral colored concrete to be achieved by the use of Color Admixtures for Color-Conditioned Concrete as specified.
   2. Stained curbs shall receive applied stained in color as approved with the mock-up. Apply stain in strict accord with manufacturer's instructions.
   3. The dosage rate of Color Admixture used must be the dosage rate specified by manufacturer for the particular color selected.
   4. Admixture Retarder to be used as specified.
   5. Color shall be as provided by Paving Schedule on drawings.
   6. Concrete mix, batching, placement and finish to be in accordance with the printed specifications of the manufacturer.

3.10 FIELD QUALITY CONTROL

A. The Owner will employ a separate testing laboratory to perform field quality control testing and to submit test reports.

B. Quality Control Testing During construction: Sampling and testing for quality control during the placement of concrete shall include the following, and as directed by the Owner's Project Manager.
   1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
   2. Slump: ASTM C 143: one test for each concrete load at point of discharge; and one test for each set of compressive strength test specimens.
   3. Air content: ASTM C 231 pressure for normal weight concrete; one test for every other concrete load at the point of discharge, or when the indication of change requires.
   4. Concrete Temperature: Test hourly when air temperature is 40° F and below, and when 80° F and above; and each time a set of compression test specimens are made.
   5. Compression Test Specimen: ASTM C 31; one set of five standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required
   6. Compressive Strength Tests:
      a. ASTM C 39; one set for each 100 cu. yds. Or fraction thereof, of concrete placed in any one day for each 5,000 sq. ft. of surface area placed; 1 specimen tested at 7 days, 3 specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
      b. When the frequency of testing will provide less than 5 strength tests, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
      c. When the total quantity of concrete is less than 50 cu. yds. the strength test may be waived by the Owner's Project Manager if, in his/her judgment, adequate evidence of satisfactory strength is provided.
      d. When the strength of field-cured cylinders is less than 85% of companion laboratory cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete
      e. Test results will be reported in writing to the Owner's Project Manager and the Contractor on the same day that tests are made.
      f. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7 day and 28 day tests.

C. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate the specified concrete and other characteristics have not been attained in the

work, as directed by the Owner's Project Manager. The testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed. Contractor shall pay for such tests as may be required, when unacceptable concrete is verified.

D. Perform survey of finished pours and remove and correct where required in order to conform to tolerances specified herein.
   1. Provide Certification of Survey to Owner as required in Division 01.
   2. Provide certifications with descriptions that show that all pavements, slabs and ramps have been surveyed.

3.11 EVALUATION OF QUALITY CONTROL TESTS

A. Do not use concrete delivered to the final point of placement which has slump or total air content outside the specified values.

B. Compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength test results equal or exceed the 28-day design compressive strength of the type of class of concrete, and if no individual strength test falls below the required compressive strength by more than 500 psi.

C. Strength test of specimens cured under field conditions may be required by Owner's Project Manager to check the adequacy of curing and protection of already placed concrete. Specimens shall be molded by the field quality control laboratory at the same time and from the same samples as the laboratory-cured specimens.

D. Improve means and procedures for curing and protecting concrete when the 28-day compressive strength of field-cured cylinders is less than 85% of companion laboratory-cured specimens.

E. If individual test of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength or if tests of field-cured cylinders indicate deficiencies in protection and curing, use additional measures to assure that the load-bearing capacity of the structure is not less than that intended by design.

3.12 CONCRETE CURING AND PROTECTION

A. General:
   1. Prevent premature drying of freshly placed concrete, and protect from excessively cold or hot temperatures until concrete has cured.
   2. Provide curing of concrete by one of the methods listed and as appropriate to service conditions and type of applied finish in each case.

B. Curing Period:
   1. Not less than 7 days for standard cements and mixes.

D. Antiquing Release Removal:
   1. After the concrete has been installed for a minimum of 7-10 days, a high pressure wash shall be used to remove the un-embedded antiquing release. An area shall be tested prior to washing to insure that the concrete is strong enough to resist damage and scaling. Care shall be taken that adjacent surfaces are not stained, and runoff is controlled in accordance with local governmental regulations.

E. Surfaces of Natural Gray Paving:
   1. Curing and sealing compound: Apply curing product compatible with specified sealer at rate stated by manufacturer to conform to moisture-retention requirements specified, using second, immediate application at right angles to first, if necessary, and reapply if damaged by rain.

F. Avoid rapid drying at end of curing period.

G. Ensure that joints and slab edges receive adequate curing.
   1. Ensure that sawn joints receive adequate curing after sawing.

H. Temperature of Concrete During Curing:
   1. When the atmospheric temperature is 40° F and below, maintain the concrete temperature between 50° F and 70° F continuously throughout the curing period. When necessary, make arrangements before concrete placing for heating, covering, insulation, or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protection complying with the requirements of ACI 306R.
   2. When the atmospheric temperature is 80° F and above, during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of windbreaks or shading, and for fog spraying, or wet sprinkling. Protect the concrete continuously for the concrete curing periods. Provide hot weather protection complying with the requirements of ACI 305R.
   3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric changes. Avoid temperature changes in concrete which exceed 5° F in any one hour and 50° F in any 24 hour period.

3.13 REMOVAL OF FORMS AND SUPPORTS

A. Perform structural repairs due to form removal only with prior approval of the Owner's Project Manager for method and procedure, using epoxy bonding systems. The Owner's Project Manager's approval is required for repair methods using materials other than those specified.
   1. Top surface repairs will not be acceptable. If repairs are required, replace entire slab and/or curb from joint to joint.
   2. Remove from site immediately all forms no longer required for the project.

3.14 SEALING

A. Acid wash exposed aggregate concrete surfaces and apply sealer on concrete pavements and curbs by airless sprayer in two coats in strict accordance with manufacturer's directions.

B. Patterned and Stained Concrete:
   1. As soon as possible after the antiquing release has been removed from patterned concrete surfaces and the stain application has completely dried, and after the moisture content of the concrete is low enough so that alkali and other salts do not become trapped beneath the sealer - normally 14-28 days after placement - two coats of sealer shall be applied evenly by airless sprayer at the rate of approximately 300-400 square feet per gallon per coat.
   2. The second coat shall be applied after the first coat is completely dry, a minimum of 4-24 hours after application of the first coat.

3.15 OPENING PAVEMENTS TO TRAFFIC

A. Do not allow traffic, including construction traffic, on pavements until authorized by Owner' Project Manager.

B. Pavements may be opened to traffic only after 7 days have elapsed after placement and pavements have developed at least 85 percent of specified strength.

C. Do not allow on the finished concrete any construction work that may stain or damage the finished appearances.
   1. Examples of unacceptable activities would be leaky high-lifts, oily pipe cutting/threading process, tire marks by earthwork equipment and anything else that may stain the finish.
   2. Contractor shall repair or replace damaged concrete as directed by Owner's Project

Manager.

3.16 CLEANING

A. Clean all concrete surfaces with a mild solution of detergent and water. Apply the solution by scrubbing vigorously with a soft bristle brush, and then flush with water.

3.17 PROTECTION

A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.

B. Do not permit pedestrian traffic over pavement for 7 days minimum after finishing.

END OF SECTION

SECTION 321540

CRUSHED STONE SURFACING

PART 1 - GENERAL

1.01 SUMMARY

A. Related Documents:
   1. Drawings and general provisions of the Subcontract apply to this Section.
   2. Review these documents for coordination with additional requirements and information that apply to work under this Section.

B. Section Includes:
   1. Crushed stone paving course, compacted.

C. Related Sections:
   1. Division 01 Section "General Requirements."
   2. Division 01 Section "Special Procedures."
   3. Division 31 Section "Rough Grading: for preparation of site for paving.
   4. Division 31 Section "Backfilling" for compacted fill for paving.

1.02 REFERENCES

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

SAN DIEGO, CALIFORNIA

1. Standard Specifications
   a. Standard Specifications for Public Works Construction (2018 Edition), including the 2018 City of San Diego Supplement.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Class 2 Aggregate Base shall conform to Section 200 of the Standard Specifications for Public Works Construction and Section 200-2.9 of the City of San Diego Supplement.

PART 3 - EXECUTION

3.01 PLACING STONE PAVING

A. Spread stone material over prepared base to a total compacted thickness as shown on the Plans.

B. Place stone in 3 inch (75 mm) layers and compact.

C. Level surfaces to elevations and gradients indicated.

D. Add small quantities of sand to stone mix as appropriate to assist compaction as directed by soils engineer.

E. Compact placed stone materials to achieve required dry density as directed by soils engineer.

F. Add water to assist compaction. With an excess water condition, rework topping and aerate to reduce moisture content.

G. Perform hand tamping in areas inaccessible to compaction equipment.

END OF SECTION

SECTION 321613

CONCRETE CURBS AND GUTTERS

PART 1 - GENERAL

1.01 SUMMARY OF WORK

A. The scope of work in this section includes concrete curbs and gutters, including but not limited to the deepened curbs, cutoff walls, curb transitions, addition of curb cut openings adjacent to the bioretention areas, preparation of subgrade, forms, joints, finishing, curing, and other appurtenant work as shown on the drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 033000 – Cast-in-Place Concrete

B. Section 079200 – Joint Sealants

C. Section 321300 – Concrete paving

D. Section 033000 – Cast-in-Place Concrete

E. Division 31 - Fill and Backfill: Compacted sub-base for paving

1.03 REFERENCE STANDARDS

A. Standard Specifications
   1. Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including the Regional Supplement.
   2. State of California, Department of Transportation, Standard Specifications, 2018.

B. Standard Drawings
   1. City of San Diego Standard Drawings for Public Works Construction, 2018 Edition
   2. San Diego Regional Standard Drawings (2012) (SDRSD).

C. American Society for Testing and Materials (ASTM):
   1. ASTM A53 Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   2. ASTM A615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
   3. ASTM A663 Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties
   4. ASTM C260 Specification for Air-Entraining Admixtures for Concrete
   5. ASTM C309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
   6. ASTM C881 Specification for Epoxy-Resin-Base Bonding Systems for Concrete

D. American Concrete Institute (ACI):
   1. ACI 117 Standard Specification for Tolerances for Concrete Construction Materials
   2. ACI 301 Standard Specifications for Structural Concrete
   3. ACI 318 Building Code Requirements for Reinforced Concrete

1.04 SUBMITTALS

A. General: Refer to Section 013300 - Submittal Procedures for submittal requirements and procedures.

B. Product Data: Submit the respective manufacturer's product data for manufactured products.

C. Shop Drawings:
   1. Submit drawings that indicate the section profile of curb and gutter, and the locations of joints in concrete, including construction joints, expansion joints, isolation joints, and contraction

joints.

2. Submit drawings of extruded curbs and gutters, if proposed, and any modification of the indicated section profile required by the extrusion process.

PART 2 - MATERIALS

2.01 MATERIALS

A. Materials for concrete curb and gutters shall be per Section 201 of the SSPWC and the applicable Regional Standard Drawings and as detailed in Section 033000 – Cast-in-Place Concrete and on the Drawings.

B. Concrete strength for concrete curb and gutter and median curb shall be 520-C-2500 minimum (SDRSD)

PART 3 - EXECUTION

3.01 TYPES OF CONSTRUCTION

A. Provide cast-in-place concrete construction, plain or reinforced as indicated. Curbs and gutters shall be formed accurately as indicated in the section profile, and SDRSD.

B. Extruded curbs and gutter, placed by an extrusion machine, may be provided where site conditions are suitable and the extrusion process is appropriate for the purpose.

3.02 CURING AND PROTECTION

A. Comply with the applicable requirements of Section 303-5 of the SSPWC.

PART 4 - MEASUREMENT AND PAYMENT

4.01 Full compensation for work that is specified, shown on the drawings, or required per the contract without a specific bid item listed for such work shall be included in the prices paid for various corresponding contract items of work in the bid schedule and no additional compensation will be allowed therefore.

4.02 CONCRETE CURB AND GUTTER, BID ITEM

A. CONCRETE CURB AND GUTTER will be measured as linear feet as shown on the plans and as determined by the Engineer.

B. The Contract unit price paid for CONCRETE CURB AND GUTTER shall include full compensation for furnishing all labor, materials, equipment, tools and incidentals for doing all the work of CONCRETE CURB AND GUTTER to complete in place, including but not limited to forms, placing, the addition of curb cut openings, transitions, deepened curb in areas adjacent to the bioretention area as shown on the Drawings and specified in these Technical Specifications.

END OF SECTION

SECTION 323113

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Chain link fencing and accessories.

B. Fence framework, fabric, and accessories.

C. Excavation and foundation for post bases.

D. Chain link fence gates and related hardware.

1.02 RELATED SECTIONS

A. Division 26 - Electrical: Power to disconnect.

B. Section 033000 - Cast-in-Place Concrete: Concrete anchorage for posts.

1.03 DEFINITIONS

A. Corner Posts: Posts located at a change in horizontal alignment.

B. End Posts: Posts located at the beginning or end of a length of fence.

C. Gateposts: Posts supporting the weight of a gate: Gateposts may function also as terminal posts but generally are sized differently.

D. Line Posts: Posts between terminal posts.

E. Pull Posts: Posts located within a length of fence at certain distances, and at changes in vertical alignment, to facilitate stretching of fabric.

F. Terminal Posts: Posts set where fence fabric terminates, and between which the fabric is stretched; a term, which includes end, corner, and pull posts.

1.04 REFERENCE STANDARDS

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM A 90/A90M-01 - Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

C. ASTM A 121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.

D. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

E. ASTM A 392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

F. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

G. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete.

H. ASTM F 567 - Standard Practice for Installation of Chain-Link Fence.

I. ASTM F 668 - Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.

J. ASTM F 1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

K. CLFMI CLF 2445 - Product Manual; Chain Link Fence Manufacturers Institute.

1.05 SUBMITTALS

A. Product Data:
   1. Manufacturer's catalog cuts. Indicate post sizes and thicknesses, protective coatings, fabric characteristics, and accessories.
   2. Samples: Color selection for polyester finishes. If requested, samples of materials (e.g., fabric, wires, and accessories).

B. Shop Drawings:
   1. Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations.
   2. Show location and spacing of posts, fittings, and accessories.
   3. Show anchorage details.
   4. Provide details of gates.

1.06 CONTRACT CLOSEOUT SUBMITTALS

A. Gates:
   1. Complete and detailed operations and maintenance data for each component, including diagrams and part numbers for ordering spare or repair parts.

B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products described in this section, with not less than three years of documented experience.

PART 2 - PRODUCTS

2.01 CHAIN LINK FENCE

A. Fence Configuration:
   1. Height: Six feet.
      a. Top rails.
      b. Brace rails at each terminal post.
      c. Bottom tension wire.
      d. Barbed wire with supporting arms.

B. Fence Fabric:
   1. Mesh and wire size: 2-inch mesh, 0.148 inch (9 gage).
   2. Galvanized steel finish: ASTM A 392, Class 2, with not less than 2.0 oz. zinc per sq. ft. of uncoated wire surface on wire coated before weaving or not less than 2.0 oz. per sq. ft. of uncoated wire surface on wire of fabric coated after weaving as determined from the average of two or more samples and not less than l.8 oz. zinc per sq. ft. of uncoated wire surface for any individual sample. Galvanize coating shall not be included in calculating required core wire diameter.

C. Fence Framework:
   1. Steel Pipe: Type 1, ASTM F 1083, standard weight, Schedule 40, minimum yield strength of 25,000 psi.
      a. Rail size: 1.660 inches outside diameter, 2.27 lb./ft.
      b. Corner, terminal and line post: 4 inches outside diameter at 9.10 lb./ft.
      c. Line Post: 1.9 inch diameter or as required for fence height.
      d. Gate Post: 3.5 inch diameter or as required for fence height.
      e. Gate Frame: 1.66 inch diameter for welded fabrication or as required for fence height.

2. Zinc coating of steel pipe and steel shapes (ASTM A 90): Interior and exterior coating, l.8 oz. per sq. ft. of coated area.

2.02 CHAIN LINK FENCE FENCING AND ACCESSORIES

A. Provide fittings according to ASTM F626.

B. Caps:
   1. Formed steel, malleable or cast iron with ring to receive top rail.
   2. Snug-fitting, weathertight closure of posts.

C. Rail Ends: Formed steel, malleable or cast iron.

D. Wire Ties and Clips:
   1. Size: Not less than fabric wire gage.
   2. Minimum zinc coating weight: 0.8 ounce per sq. ft.

E. Brace Bands and Tension Bands:
   1. 3/4-inch by 1/10-inch thick (nominal).

F. Tension Bars:
   1. Continuous length to match fabric width.
   2. Not required for roll-formed posts with integral fabric weaving loops.

G. Tension Wire: 7 gage, coil spring wire.

H. Truss Rods: 5/16-inch minimum diameter rod.

I. Hardware and lock for Double Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; drop bolt on inactive leaf engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp; keepers to hold gate in fully open position.

J. Finish: To match fence framework.

2.03 HORIZONTAL SLIDE GATES

A. Cantilever Slide Gates: In compliance with ASTM F1184 Type II
   1. Class 1-External Roller Design: Horizontal top and bottom steel pipe “track” members to be 2.375 in. OD (60.3 mm). Vertical and internal members, 1.900 in. O.D. Gate frame to be fabricated by welding, vertical and horizontal members installed no greater than 8 ft. (2440 mm) apart. Welded joints are to be protected by applying zinc-rich paint in accordance with ASTM Practice A780. Gates designed to open or close by applying an initial pull force no greater 40 lbs. (18.14 kg). Match chain link fabric to that of the fence system. Positive locking pressed steel latch, galvanized after fabrication. Galvanized steel drop bars provided with double gates. Gateposts, 4.000 in. OD (101.6 mm) schedule 40 pipe per ASTM F1083. Provide safety protective guards for the top and bottom external rollers following ASTM F1184 guidelines.

2.04 SLIDE GATE OPERATOR

A. Basis of Design: LiftMaster SL3000 AC High Traffic Commerical Slide Gate Operator

B. System shall be integrated into existing security system

C. Electrically operated horizontal slide gates must be manufactured and installed to comply with the safety requirements of ASTM F2200 and UL 325

2.05 CONCRETE

A. Concrete materials are specified in Division 03.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that line of fence has been properly identified.

B. Verify that proper grade has been established.

C. Verify location of underground utilities and structures.

D. Begin fence construction only after adequate clearance on both sides of fence is available.

3.02 INSTALLATION - POST

A. Layout:
   1. Space line posts at equal distance intervals not exceeding 10 feet on center measured parallel to grade.
   2. Locate terminal posts at the beginning and end of each continuous length of fence, at abrupt changes in line or grade, additionally at intervals not to exceed 500 feet, and as otherwise shown on the drawings.
   3. Install posts plumb and in proper alignment.

B. Anchorage of Posts in Soil:
   1. Set posts in concrete-filled holes, securely braced in proper position until concrete has cured at least 3 days above 60 degrees F.
   2. Hole shall be free of loose materials when placing concrete.
   3. Hole diameter shall be as recommended by fence manufacturer, but not less than 4 times largest cross section of post.
   4. Minimum hole depth for line and terminal posts:
      a. 36 inches for fence up to 8 feet high.
   5. Increase hole depth as necessary to provide at least 2 inches of cover under bottom of post. Do not allow post to contact soil.
   6. Remove and dispose of waste excavation material off site or spread in approved locations, as directed.
   7. Thoroughly consolidate concrete.
   8. Extend concrete 2 inches above grade, forming a crown to shed water.

3.03 INSTALLATION - CHAIN LINK FENCE

A. Install posts, braces, fabric, and other components in accordance with manufacturer's recommendations and approved shop drawings and to meet or exceed requirements of ASTM F 567.

B. At Ride Restriction fences, and other locations as designated on the drawings, install the fabric on the guest side of the post and rail framing to reduce the opportunity to utilize the frame structure for climbing. Refer to diagrams on drawings.

C. Pull fabric taut and secure to tension wires at 1 foot on both sides of each post and at intervals of 24 inches, maximum, on center.

D. Secure fabric to line posts with tie wires or clips at intervals of 15 inches, maximum, on center.

E. Secure fabric to terminal posts for the full width of fabric by using stretcher bars and bands or by integrally weaving fabric to fastening loops on posts.

3.04 INSTALLATION - CHAIN LINK FENCE GATE

A. Install gates in accordance with manufacturer's instructions, plumb, level, and secure.

B. Gates shall operate freely without binding or dragging and shall be easily operable by hand.

3.05 CLEANING

A. Clean up debris and unused material, and remove from the site.

3.06 TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm).

B. Maximum Offset From True Position: 1 inch (25 mm).

C. Components shall not infringe adjacent property lines.

END OF SECTION

SECTION 323119

DECORATIVE METAL FENCES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Industrial Aluminum Ornamental picket fencing and accessories.

1.02 RELATED SECTIONS

A. Section 055000 – Metal Fabrications

B. Section 033000 - Cast-In-Place Concrete

C. Section 321300 - Concrete Paving

1.03 REFERENCES

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
   2. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
   3. ASTM D523 - Test Method for Specular Gloss.
   4. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.
   5. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
   6. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
   7. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
   8. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   9. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.
   10. ASTM F2453/F 2453M – Standard Specification for Welded Wire Mesh Fence Fabric

1.04 SUBMITTALS:

A. Product Data: Manufacturer's data sheet for each product, including:
   1. Compliance with requirements.
   2. Preparation instructions and recommendations.
   3. Installation methods.

B. Shop Drawings:
   1. Show overall fence layout.
   2. Show location, height, and spacing of posts, fittings, and accessories.
   3. Show depth of posts and concrete for each type of post.
   4. Show anchorage details.
   5. Provide details of gates.

C. Samples: Submit two samples of manufacturer's full range of colors for finish.

1.05 PRODUCT HANDLING AND STORAGE

A. Upon receipt at the job site, all materials shall be checked to ensure that no damages occurred during shipping or handling. Materials shall be stored in such a manner to ensure proper ventilation and drainage, and to protect against damage, weather, vandalism and theft.

1.06 SPECIAL WARRANTY

A. Provide manufacturer's standard limited lifetime warranty that its ornamental fence system is free from defects in material and workmanship including cracking, peeling, blistering and corroding for as long as the original purchaser owns the fence.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Basis of Design: Ameristar WireWorks Plus, aluminum fencing produced by Ameristar Fence Products, Inc., Tulsa, OK.
   1. Height: 8'-0".
   2. Mesh Size: 2" x 6".
   3. Color: Black.

B. Substitutions: Products from other qualified manufacturers having a minimum of 5 years of experience manufacturing aluminum ornamental picket fencing may be considered acceptable by the Owner as equal if submitted for substitution in accordance with Section 016000 and meeting the design and quality established by the contract documents.

2.02 MATERIAL

A. Steel material for fence posts shall be galvanized prior to forming in accordance with the requirements of ASTM A653/A653M, with minimum yield strength of 45,000 psi (310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.60 oz/ft^2, Coating Designation G-60. Fence posts and gate posts shall meet the minimum size requirements of Table 1.

B. Steel wire mesh fence panels shall be welded by resistance welding per ASTM A185 using 6 gauge (0.192 inch) pre-galvanized steel wire, welded at each crossing to form rectangles. Vertical 6ga. (0.192) wires shall be spaced at 2 inches; horizontal 6ga. (0.192) wires shall be spaced at 6 inches. The cold rolled wire shall have a tensile strength of at least 70,000 PSI and 74,000 PSI weld shear strength. Wire strand shall be galvanized before welded (GBW), .050 ounces per square foot zinc coating conforming to the ASTM A641.

2.03 FABRICATION

A. Panels and posts shall be precut to specified lengths. Panels shall have a number of structural folds based on the specified panel height as follows:
   1. 48" height x 96" width panel – 2 horizontal panel folds
   2. 69" height x 96" width panel – 3 horizontal panel folds
   3. 96" height x 96" width panel – 4 horizontal panel folds

B. The manufactured panels and posts shall be subjected to an inline electro-deposition coating (E-Coat) process consisting of a multi-stage pretreatment/wash (with zinc phosphate), followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The coated panels and posts shall be capable of meeting the performance requirements for each quality characteristic shown in Table 2.

C. Swing gates shall be fabricated using 2" x 12ga square rails and gate ends. Gates that exceed 6' in width will have a 2" sq. x 12ga. intermediate upright. All rail, upright, and gate end intersections shall be joined by welding. Steel gussets (1/4" x 2") shall be welded at each rail to gate end intersection and rail to intermediate intersections (4 gussets per gate bay). Gusset shall be punched to accept gate trussing cable and turnbuckle.

D. Refer to section 055000 for supplementary hardware information.

2.04 ACCESSORIES

A. All fasteners to be stainless steel. Bracket to rail attachments to be one-way tamperproof security bolts. Bracket to post connections to be self-drilling hex-head screws.

B. Rings, Finials and Post Caps: Aluminum casting. Provide weather-tight post cap for each post. Flat top cap either 2/12” or 4”.

2.05 SETTING MATERIAL

A. Concrete: Minimum 28-day compressive strength of 3000 psi per Section 033000.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Field verify areas to receive fencing are completed to final grades and elevations.

B. Ensure property lines and legal boundaries of work are clearly established.

3.02 INSTALLATION

A. Install fence in accordance with manufacturer's instructions.

B. Space posts uniformly at 6'-0” o.c. maximum face to face unless otherwise indicated.

C. Concrete Set Posts: Drill hole in firm, undisturbed or compacted soil. Holes shall have a minimum diameter of 4 times greater than nominal outside dimension of post, and depths approximately 6” deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 18” below surface when in firm, undisturbed soil. Place concrete around post in a continuous pour. Trowel finish around posts and slope to direct water away from posts.
   1. Gate Posts and Hardware: Set keepers, stops, sleeves and other accessories into concrete.

D. Check each post for vertical and top alignment, and maintain in position during placement and finishing operation.

E. Align fence panels between posts. Firmly attach rail brackets to posts with 1/4” (6 mm) bolt and lock nut, ensuring panels and posts remain plumb.

3.03 ACCESSORIES

A. Install post caps and other accessories to complete fence.

3.04 CLEANING

A. Clean up debris and unused material, and remove from site.

B. Leave fence in clean condition.

END OF SECTION

SECTION 328400

LANDSCAPE IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work consists of installing a complete automated underground irrigation system as shown on the Drawings and hereinafter specified in accordance with all government standards and regulations.

B. Existing site is to incur some modifications with existing water supply lines. Coordinate with the Owner's representative with work phasing in the beginning of project and throughout the construction period. The final site irrigation water source will be activated at the appropriate time coordinated with Owner.

C. The work includes installing temporary irrigation systems to water affected plantings where systems have temporarily been lost due to construction activities; both inside and outside the temporary demolition and construction areas. Irrigation systems to remain in place that are affected in any way by the new construction work shall be adjusted as required by Contractor to meet full irrigation coverage on both sides of project construction fences, where occurs, and shall remain in service throughout the demolition and construction period. Sea World landscape staff will, upon review with the contractor and approval of all system modifications by Contractor, maintain the landscape in these areas. Close coordination is expected of the Contractor with Sea World landscape maintenance throughout the demolition and construction period.

D. All existing irrigation systems outside the project affected by project demolition and construction shall be connected to temporary PVC mainlines (or other Owner approved pipe material) and control wires (and conduit where necessary) insomuch as possible, at the project construction fence on the side of fence designated for such purpose. Temporary asphalt (e.g. Coldmix) shall be provided by the Contractor on an as-needed basis where required to minimize interference with or present a hazard to usage of roads, sidewalks, driveways, and other affected facilities.

E. When required, the Contractor shall bypass sections of the existing irrigation main line and system control wires with a temporary above-ground supply line (high-line) as noted on the drawings, as directed and as required during all phases as shown on the Construction Schedule. The Contractor shall provide high-line system installation shop drawings to the Owner's representative for approval prior to ordering or purchasing material.

F. The Contractor shall provide the Owner's representative a schedule for the high-line work at least 10 days prior to work required for each phase (e.g., connections or disconnects). The work includes shutoff valves to isolate sections of the high-line if there is a leak or break to minimize the water service shutdowns. The high-line system shall provide continuous full service to connected water services until the new mainline is installed and in operation. The Work shall be coordinated, scheduled, and performed to minimize disruption of water services during installation and removal of the high-line system.

G. The Contractor shall flush, leak test, and fix leaks on all high-line systems in coordination with the Owner's representative.

H. The Contractor shall ensure proper arrangement, installation, maintenance, pressure control, and operation of the highline to avoid damage to property and related public health and safety issues.

I. The Contractor shall dismantle and remove the high-line system from the site, and restore disturbed facilities and surface improvements promptly when ready to complete permanent reconnections.

J. The work shall include the furnishing of all labor, equipment, materials, permits, and supervision in performing all operations in connection with the demolition work and construction of the irrigation system.

K. The Bidders are advised that all work will be performed in a thorough, proper, and professional manner, and that the implementation of substandard or otherwise unapproved materials or methods will not be permitted.

1.02 GENERAL DESCRIPTION

A. The irrigation system shall be constructed using the materials and methods shown on the drawings and construction details and called for in these specifications. The system shall be constructed to grades and conform to areas and locations as shown on the drawings or in compliance with design build specifications.

B. The work includes boring under sections of existing pavement to provide irrigation into areas which have not been provided previously. Choose the least disruptive manner to protect existing facilities. Coordinate with Owner's representative the method, crew, and schedule for approval prior to doing any work.

C. The locations of irrigation lines and equipment shown on the drawings are largely diagrammatic. Mainline, valve and supply locations shall be staked out by the Contractor and approved by the Owner prior to installation. Location of all other equipment and routing shall be as close as practical to those shown on the drawings. Mainline location shall also be coordinated to avoid conflicts with pavement, easements, and rights-of way, trees and/or other obstructions, unless noted on the plans.

D. The construction of the irrigation system shall include the furnishing, installation, and testing of all mainlines, lateral piping, fittings, air release valves, sprinkler heads, swing joints, dripline and drip components, valves, backflow preventers, booster pump, flow meters, check valves, wye strainers, test stations, controller equipment, rain gauges, wiring, supply connections, all other pertinent materials and accessories, the removal and/or restoration of existing improvements, excavation and backfill, and all other work in accordance with the drawings and specifications, as required for a complete, functional, and fully warranted system.

E. Irrigation System Audit: Contractor shall have an irrigation audit performed by a certified irrigation auditor or certified water manager certified through the Irrigation Association to assure proper operation, coverage and water conservation of all newly installed systems.

F. Although architectural considerations may result in some differences of criteria between various areas of the project, the Contractor shall maintain uniformity of construction methods and materials throughout.

1.03 RELATIONSHIP OF THE DOCUMENTS

A. The contractor, upon completion of project, is required to provide site verified irrigation as-built AutoCad drawing to the Owner's Design and Engineering Department and Landscape Department. Coordinate as-built work with Owner's representative and Landscape Architect prior to preparing to ensure the intent, content and quality of the drawings meets the requirements for an accurate record of what exists and is installed.

B. The drawings for this project and these written specifications are to be considered totally integral, with neither considered complete without the other. The Bidders shall thoroughly examine and familiarize themselves with all the information contained in the documents, and by submitting a bid for this work, agree to accept and be bound by all the provisions made in the Documents.

C. Should a conflict arise between the information contained in the Drawings and these Specifications, the Drawings shall control, unless the item in question is part of an Addendum,

dated later than the Drawings. The Owner or his chosen Representative shall be notified immediately of any such discrepancies, and shall take any corrective action deemed necessary.

D. All work shall conform to the most recent issue of the Documents.

1.04 ALTERNATE PRODUCTS AND METHODS

A. Specific equipment, performances, installation methods, and other such criteria have been selected for use in the design of this project, and these shall be considered the basis for the Base Bid. The use of alternate equipment and/or methods shall not be acceptable without prior approval. Consideration shall be given only for those materials and methods whose performance most closely matches that which is contained in the original Documents, and most reasonably serves the intent of this design.

B. Any modifications or other impact to this design which may be necessitated by the submission of alternate equipment and/or methods shall be clearly noted within the submittal, and subsequently acted upon by the Owner. The Bidders shall warrant that any bid submitted for any equipment shall include all materials and work necessary for the proper and fully warranted installation of that equipment, including, but not limited to, increased pipe or wire size, fittings, concrete, gravel, or any other associated materials and/or labor.

C. It may be requested that the Bidders provide recommendations and alternate pricing for value engineering items. A request for such alternatives does not constitute approval by the Owner or Architect for implementation of these items. All changes will require written approval.

D. Related Work Specified Elsewhere: Consult the Owner for documents pertaining to other trades relative to this work.

1.05 SUBMITTALS

A. Requirements:

1. Prior to commencement of work under this Contract, the Contractor shall submit one complete set of submittal data on all proposed materials and equipment, including, but not limited to, sprinklers, nozzles, subsurface irrigation, above grade irrigation equipment and piping, low volume/drip irrigation equipment, valves, valve ID tags, pipe, conduit, flow meters, valve ID tags, valve boxes, controllers, trench warning tape, PVC cement and cleaner, wire and connectors, fittings, service saddles, swing joints, filter fabric, backflow preventers, backflow preventer enclosures, wye strainers, check valves, pump assembly and supply line P.O.C. hardware. The data shall include copies of all manufacturers' warranty information, including documentation of any extended warranties, if applicable to this project.

2. Product submittals shall be one complete set with various sections tabbed and properly indexed. Include a Table of Contents with each sections and product corresponding with a page number. Each item shall be marked as acceptable to the Owner’s Representative before it shall be considered for approval by the Landscape Architect.

3. Required Daily Information for As-Built Drawing Preparation:

a. Prior to the final project walk-through, and prior to final acceptance of work, the Contractor shall provide a record set of drawings indicating the daily progress of irrigation system work and degree of completion for the work. Utilize one clean, complete set of irrigation drawing prints used for installing system. Make daily annotations thereon as project progresses, prior to review by Owner’s Representative and prior to burial of irrigation facilities. Lettering shall be in red ink and 1/4" height minimum. Final submitted information shall be on a clean, full size set of bond copy prints for reproduction purposes. All items changed/relocated from original drawings shall be so indicated with the same symbol in the new location, the original symbol erased or hatched out. All notes/callouts pertaining to the item shall be directed to new location. Show sizes of all mainline segments, sleeves and conduits. All work shall be

neat, in red ink and subject to the satisfaction of the Landscape Architect and/or Owner's Representative. Once approved by the Landscape Architect and/or Owner's Representative, obtain one (1) reduced print copy of record drawings (11"x 17" format), laminate in plastic, and submit to Landscape Architect and/or Owner's Representative.

b. Location and Accessibility: The As-Built information shall be kept on the job site in the possession of the Contractor, and shall be kept available for inspection at any time by the Owner's Representative.

4. Immediately upon the installation of any pipe or equipment, the contractor shall indicate on the drawings the locations of said pipe or equipment. All locations of main line, and all conduits and sleeves shall be noted on plans with number, size and depth of cover at each location. Any detours around obstacles shall be noted with description of the obstacle and how the installation detoured, (for example, "shallow bury- 12" cover", or otherwise described for each occurrence). Indicate any zone area (square footage) changes, to Owner's Representative. Coordinate as-built work with Owner's representative and Landscape Architect prior to preparing drawings to ensure the intent, content and quality of the drawings meets the requirements for an accurate record of what exists and is installed.

5. Any changes in type/manufacturer/model number/size of equipment or installations from that shown on Drawings shall be so indicated on the Record Drawings. This includes irrigation legends, irrigation notes, irrigation details and any other information included in the construction of project.

6. All remote control valves shall be numbered by station and corresponding numbers shall be shown on the record drawings.

7. All routing of electrical wire shall be noted starting from the controller to each valve/valve manifold. Note the number of any spare wires stubbed out on wire runs.

8. All sensors, meters, water mains, control wiring, mainline and lateral line stub-outs, points of connection to water mains, controllers, controller electrical circuit panel with circuit number indicated, controller Ethernet service connection point and address, pull boxes, wire splice boxes, sleeves, flow meter cable conduits with routing, control wire conduit with routing, wire stub-out with number of wires indicated, remote control valves, master valve/flow meter, drip air/vacuum relief valves, drip lateral flush valves, remote control valves, shut-off valves and quick coupling valves shall be located by measured dimensions, to the nearest one-half foot. Dimensions from two (2) different reference points minimum shall be given from permanent objects such as face of curbs, drain inlets, sidewalks, walls, structures and driveways. Use the nearest, best points of reference for documenting the dimensions for each item. Indicate lateral line routing to system where valve location and/or lateral line is any different than plans. In addition, all bends and offsets for the mainline shall be indicated, and cut and cap of existing facilities. All existing irrigation facilities which are cut and capped, or modified in any way, or found unknowingly, shall be noted on the as-builts. All major obstructions or objects deviated around during installation shall be noted on the as-builts.

9. Record drawings shall be signed and dated in black ink by the Contractor attesting to and certifying the accuracy of the record drawings. Contractor shall indicate company name, address and phone number on record drawings.

10. As-Built Drawing Production:

The Contractor shall be responsible for preparing, or causing to be prepared, reproducible "As-Built" Drawings from the record data, printed on archival quality media. These Drawings shall be surrendered to the Owner prior to final acceptance and payment for the work. Failure

to do so may result in forfeiture of bonds or retainages held, and/or other reparations available to the Owner under the law.

11. Controller Charts: For the inside surface of the cover of each Automatic Controller, prepare a color-coded chart showing the valves, mainline, and systems serviced by that particular Controller. All valves shall be numbered to match the operation schedule and the drawings. Only those areas controlled by that Controller shall be shown. This chart shall be the as-built plan, entire or partial, showing building, walks, roads and walls. A photostatic print of this plan, reduced as necessary and legible in all details, shall be made to a size (11"x17" size) that will fit into the Controller enclosure. This print shall be approved by the Landscape Architect and/or Owner's Representative and shall be hermetically laminated by plastic. This shall then be placed inside the enclosure door, or in an agreed to location given by the Owner's Representative.
12. Contractor shall have an irrigation audit performed by a certified irrigation auditor or certified water manager to assure proper operation, coverage and water conservation of all newly installed or upgraded systems.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. All material and equipment shall be supplied by the Contractor. The one exception shall be one controller, which shall be supplied by the Owner’s representative and installed by the Contractor. Substitutions shall not be permitted without prior written approval of the Owner. The Contractor shall inspect all material and equipment prior to installation, and any materials or equipment found to be defective shall be removed immediately from the site and replaced with the proper items. All materials shall be new and in current production. The use of demonstration, beta test or pilot run materials or equipment shall not be permitted without written authorization of the Owner. Any cost savings derived from the use of such equipment shall be passed on to the Owner.
2. Any items used in the installation which are subsequently found to be defective, improperly installed, or not as specified herein and on the Drawings, shall likewise be removed and replaced with the proper materials and equipment, and installed in the proper manner, as interpreted by the Owner. Any work done or materials used for this purpose shall be provided by the Contractor at no cost to the Owner.

B. Pipe:

1. PVC Pipe: All mainline pipe in the system, unless specifically excepted on the Drawings, shall be potable water use designation and as follows: Class 200 PVC Pipe with integral gasketed ends for 4” size; Class 315 PVC Pipe for 2” to 3” size; Schedule 40 PVC Pipe for 1-1/2” and smaller size, purple color. Lateral piping shall be Schedule 40 PVC pipe, white in color. Pipe shall be equipped with integral belled ends at one end. All piping except crossings, sleeves or metal piping shall be of the same manufacture.

2. Pipe running through sleeves will require a 1 foot clearance on both ends before connecting to this pipe.

3. Metal tape marked “Irrigation” shall top 12” above sleeves.

4. Sleeve Pipe: Schedule 40 solvent-weld, bell-end PVC, white in color. Pipe shall be sized a minimum of two sizes larger than pipe contained therein, or as shown on the Drawings, whichever is the larger.

5. 2 spare wires and a matching pipe size shall be installed in each sleeve.

6. Pipe shall be delivered to the site in full 20-foot lengths, and shall be clearly and permanently marked with manufacturer's name, classification, and code references.

7. Brass pipe and fittings: Brass pipe shall be 85% red brass, American National Standard Institute (ANSI), Schedule 40-screwed pipe. Fittings shall be medium brass, screwed 125-pound Class.

8. Hard copper tube and fittings: Copper tube (pipe) shall be ASTM B 88, Type K water tube.

   a. Fittings shall be ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings for 2 1/2 inch size and smaller pipe.
   b. Cast brass fittings shall be used for pipe over 2 1/2 inch size
   c. Bronze Flanges: ASME B 16.24, Class 150, with solder-joint end.
   d. 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.

9. Nipples and risers:
   a. Metallic: red brass, standard pipe size, schedule 40, ASTM b43. Composition: nominal copper content to be 85 percent (min. 83%, max. 86%), nominal zinc content to be 15 percent. Maximum allowable lead and iron content to be 0.05 percent each.
   b. Plastic: plastic nipples and risers shall be manufactured rigid virgin polyvinyl chloride PVC, (Type 1, Grade 1), conforming to ASTM D 1784 or D 2464, designated as Schedule 80 with molded threads.

10. Fittings and Connections:
   a. Threaded connections: Teflon tape or approved equivalent, UL listed.
   b. Gasketed fittings: Lubricant per manufacturer’s recommendations.
   c. Flanged connections: shall be jointing material type as recommended by manufacturer of pipe fittings.
   d. The use of saddle-type fittings shall NOT be permitted.
   e. Solvent weld connections with primer and adhesive solvent shall be type as recommended by manufacturer of pipe and fittings Refer to pipe installation section for specific materials. All cans of solvents and primers shall have labels intact and shall be stamped with the date and manufacturer. No cans dated over two (2) years old will be permitted.
   f. No thinning of solvent or primer in any manner will be permitted.
   g. Pressure Fittings: All pressure fittings for PVC pipe, unless specifically shown on the Drawings, shall be Sch 40 PVC.
   h. Swing Joints: Swing joints for sprinkler heads shall be per Drawings.
   i. Non-Pressure Fittings: All non-pressure fittings for PVC pipe, unless specifically shown on the Drawings, shall be Sch 40 PVC. Flexible PVC pipe and polyethylene pipe fittings shall be as noted on the Drawings.

11. Sprinkler Heads:
   a. Heads shall be as indicated on the Drawings. It shall be the responsibility of the Contractor to provide these heads complete with any options or special features specified on the Drawings, which may include pressure regulation, anti-drain mechanisms, rubber covers, side inlets, etc. Sprinkler performance shall be equal to, or greater than, the design performance indicated on the Drawings. Refer to the Drawings for additional information.
   b. Contractor to install heads for head-to-head coverage.
   c. No 45 degree elbows will be used for installation of PVC Systems.
   d. There will be a minimum of 8” between fittings.
   e. No threaded parts will be used on the PVC piped system other than on the heads or valves.
   f. Any spray head located in such a manner that a standard nozzle pattern is not appropriate shall be installed with an adjustable arc nozzle of appropriate type for the

location. This shall be done whether or not the adjustable arc nozzle is specifically called for on the Drawings.

g. 6” and 12” pop-up heads are to be used throughout the project, unless otherwise noted on the Drawings. Risers above finish grade are not to be used.
h. Drip and Low-Volume Equipment: Refer to the Drawings for pertinent information to provide a complete system.
i. Refer to the Drawings for pertinent information to provide a complete system.
j. Provide the size control valve assembly and pressure regulation required for the maximum flow rate of the system.
k. All components to be used shall be compatible with all dripline, tubing or fittings/connections. Contractor shall ensure all components meet this requirement. Any components not fitting will be replaced promptly with compatible materials.
l. Micro-spray shall be Rain Bird UXB-360-025, discharge at 0.3 gpm at 20 psi.
m. ¼” blank dripline tubing for hanging baskets shall be as Rain Bird XQ-XXX, black color, or approved equal.
n. ¼” dripline tubing for hanging baskets and planter pots shall be such as Rain Bird LDQ-08-06-100, brown color, or approved equal.
o. 3/4” blank dripline tubing for hanging baskets shall be such as manufactured by Netafim, black color, or approved equal.
p. Stakes for ¼” dripline tubing shall be plastic and match the tubing used. Staples for larger dripline shall be 6” soil staple such as is manufactured by Netafim.
q. Dripline and fittings/connections for planter pots, hanging planters and plant pockets shall also be as noted on the Drawings.

12. Flow meters:
    a. Flow meters where required shall be 1-1/2” Calsense FM-1.5B.
13. Check Valves shall be as shown on the Drawings and per Water Agency requirements.
14. Valve Boxes:
    a. Refer to the Drawings for other pertinent information.
    b. Valve boxes for zone valves shall be sized and installed per Drawings.
    c. All valve boxes shall be commercial grade, integral colored, with one piece top, locking bolt-down green lids, by Carson-Brooks, Ametek or approved equal. All box lids shall be equipped with stainless steel washer and stainless steel locking bolt. Boxes/lids to be tan color where located in DG areas. Boxes/lids to be green color in existing landscape areas.
    d. Valve box extensions shall be of the same manufacturer as valve box to be adjusted to finish grade, same in color as valve box.
    e. For each ball valve 1-1/2” and smaller: 10" nom. diameter round plastic valve box.
    f. For each gate valve: 10" nom. diameter round plastic valve box over PVC sleeve.
    g. For each sensor: 10" nom. diameter round plastic valve box.
    h. For each quick coupling valve: 10" nom. diameter round plastic valve box.
    i. For each remote control valve: 14" x 19" nom. plastic valve box.
    j. For each in-line check valve: 10" nom. diameter round plastic valve box.
    k. For each drip air vacuum relief valve and flush assembly: 10" nom. diameter round plastic valve box.
    l. For wire splice box and pull box in landscape: 10” nominal diameter round plastic valve box, marked “Electrical.” If wire stub-out would occupy in excess of ½ the volume of box, install wire bundle in 14” x 19” nom. green plastic valve box, marked “Electrical” on lid.
    m. For pipe or sleeve stub-out box in landscape: 10” nominal diameter round plastic valve box.
    n. For boxes in pavement or in areas subject to vehicular traffic, use traffic rated concrete box with brass lid, and as noted on the Drawings.
    o. 10” dia. Round Valve boxes at all sleeve locations (one within two feet (2’) of each end of sleeve).

15. Wire:
    a. All wire used in this work shall bear permanent markings showing size and ratings.
    b. Low-voltage control wiring shall be Type UF single conductor solid copper cable, with PVC insulation. Valve “hot” wires and spares shall be UF#14-1, and Valve common wires shall be UF#14-1. Wire shall be colored red for "hot" wires and spare wires, and black for valve common wires. "Irrigation" type wire with PE jacket or multi-conductor type wire for station control shall be UNACCEPTABLE.
    c. A blue wire will be used as the common for the master valve.
    d. A purple wire will be used as the station wire for the master valve.
    e. Flow sensor wires shall be UF#14-1 in conduit between flow sensor and controller. Green and yellow wire will be used for the flow sensor.
16. Control System: existing Calsense ET2000e controllers with weather based control.
17. Control Valves:
    a. The exact number of zone control valves required shall be determined in the field during construction. See also Installation Section. Systems shall have a maximum of the 55 G.P.M., with the valve size based on flow. Valves shall be sized with type indicated on the Drawings, and shall be equipped with any additional features indicated therein.
    b. Zone control valves shall be furnished with, and operated by, low-power electric solenoids with a nominal operating voltage of 24 VAC.
    c. Run a spare common wire and station wire to all the furthest valves on the system. In addition, where spare wire box is indicated on Drawings, provide two spare control wires and the common wire from controller to spare wire box. Label as “spare” and waterproof wire ends.
    d. All control valves will be located within one foot along the edge of pathways or in locations as directed by Owner’s representative for easy accessibility.
    e. Master valves will be a cast-iron and brass type, Griswold, model numbers as noted: normally open 1” valve shall be Model No. 2160, epoxy coated. Normally closed 3” valve shall be Model No. 2010, epoxy coated.
18. Gate Valves:
    a. Isolation gate valves for two-inch (2”) and larger size shall be Nibco P-619-RW w/ square operating nut, with iron body, brass or bronze mounted AWWA gate valves, and shall have a clear waterway equal to the full nominal diameter of the valve, and shall be rubber gasket, flanged or mechanical joint only, and shall be able to withstand a continuous working pressure of 150 psi. Valve shall be equipped with a square-operating nut.
19. Ball Valves:
    a. Unless specifically accepted on the Drawings, ball valves used for isolation or throttling purposes shall be a socket slip x slip type valves, sized to match mainline.
    b. All connections shall be slip x slip.
    c. Valves shall be of domestic manufacture.
    d. Ball valve before valve manifolds: maximum 3 remote control valves per ball valve.
    e. A ball valve(s) matching the mainline size will be installed to interconnect systems.
    f. A ball valve with a lockout handle should be installed on the inlet standpipe prior to the backflow preventer. This will allow the device to be turned off without shutting down areas of the park. New backflow preventers will require backflow preventer certification provided by a currently certified backflow preventer tester in the County of San Diego. New backflow preventers and backflow preventers being relocated shall be installed by a licensed plumber.
20. Backflow preventers: all new backflow preventers shall be Wilkins 975XL.
21. Quick Couplers:
    a. Quick couplers throughout the project shall be installed at different locations on both sides of the pathways and have an isolation ball valve.

b. All quick couplers shall be ¾" brass, 2 threaded risers and 1 threaded 90 elbow.

c. All quick couplers shall have the brass part installed in concrete, leaving the end riser open for a threaded PVC male adaptor.

d. On all new projects a separate mainline for the quick couplers shall be installed for wash down and a quick coupler located every 75' along the pathway.

PART 3 - EXECUTION

3.01 SUBSTITUTIONS

A. Grade and Quality: Any substituted product or method shall be equal or superior in all respects to the specified product or method, shall equal or exceed the warranty of the specified product or method, and shall be compatible with all other components in use on the project. See also Section 016000 for substitution procedure form.

B. Any substituted product or method shall be equal or superior in all respects to the specified product or method, shall equal or exceed the warranty of the specified product or method, and shall be compatible with all other components in use on the project. See also Section 1.01-D.

C. Protocol:

1. The Contractor shall submit with his bid, a request for substitution, which shall include all available manufacturer's data (if a product), names of six similar projects where the alternate product or method has been successfully used, an itemized comparison of proposed substitutions, the exact cost difference, and the Contractor's specific reason for the substitution.

2. In the event that a less costly type of equipment is accepted for use on the project, or any equipment is omitted from the work, the Contractor shall fully refund the difference to the Owner, regardless of whether the action was initiated by the Owner or the Contractor.

3.02 INSTALLATION

A. General:

1. The Contractor shall install a fully operational and warranted automatic irrigation system. Any and all materials and prevalent methods necessary to do so shall be provided by the Contractor as part of this contract, even if not specifically called for in the Drawings and/or these Specifications.

2. The Contractor shall obtain all the necessary permits and inspections for this work, and shall be responsible for penalties or damages which may result from his failure to do so.

3. The content and enforcement of standards, codes and regulations may vary from job to job. Information contained in these documents is for reference purposes ONLY, and shall not be considered an absolute interpretation of prevailing requirements. The responsibility for researching all local code requirements, and for conformance thereto, shall remain solely that of the Contractor.

4. The Contractor shall review any associated land use or environmental permits, and shall adhere to any special conditions therein.

5. It is the Contractor's responsibility to attend an on-site pre-construction meeting and regularly scheduled on-site construction meetings to coordinate activities with other trades. Refer also to Section 010300 Summary of Work.

6. It is the Contractor's responsibility to interface and communicate with the Owner's Representative during the construction process.

B. Design Considerations:

1. 6” or 12" pop-up Hunter Pro Spray series heads including, but not limited to the MP Rotator (stream rotor nozzle) head or Hunter rotors, shall be used in the project – risers are not acceptable. In any area where raising the head above grade is unavoidable, the heads shall be inset directly into the closest shrub, and complete concealment and protection shall be provided.

2. Although due diligence has been given to the design of the system, it shall be understood that the Drawings are entirely diagrammatic in nature, and conflicts may appear due to field variables or other factors. It shall be the responsibility of the Contractor to field-coordinate the entire installation, including rock work, tree locations, bed lines, etc., and make appropriate adjustments so that all plant material receives the proper coverage, and in the manner set forth in the Documents.

3. Systems shall be installed in a matter so as to conserve water and eliminate any overspray or wasteful water applications. Systems shall conform to current water conservation standards and regulations.

C. Existing Conditions:

1. The Drawings show conditions as they are believed to exist, but it is not intended, nor should it be interpreted, that the conditions shown constitute a representation by the Owner that the conditions actually exist.

2. The Contractor shall personally inspect the job site prior to bidding, to fully familiarize himself with the nature of the work, and shall accept full responsibility for any loss sustained as a result of differences between the conditions shown on the Drawings and any actual condition revealed during the completion of the work.

3. The Contractor shall, prior to excavation, verify the location of any and all existing underground improvements, and shall take any action necessary to protect said improvements during his work, and eliminate service outages. This may include, but not be limited to, existing irrigation within, or adjacent to, the work area. It shall be solely the responsibility of the Contractor to obtain the necessary locates and dig permits for the work area.

4. The Owner shall determine the disposition of any salvageable equipment from the demolition of existing irrigation systems. Items shall not be removed from the site without prior Owner approval. The Contractor shall be responsible for a seamless interface with any existing irrigation which is to be retained, regardless of whether the existing work will be tied into the new work or is only adjoining the new work.

5. The Contractor shall be responsible for the repair of existing systems impacted by construction activities. The Contractor may need to establish a temporary watering system for established plantings, in or outside the limits of construction, impacted by assigned construction activities.

6. Damage to the existing system done by the Contractor in the course of the work shall be repaired as part of the work. Pre-existing damage shall be reported to the Owner, and repaired at his discretion.

7. Contractor shall not randomly choose any wires, instead he must tone trace the appropriate station wires, as not to disrupt the normal water cycles of the other stations on the controller. If so then the Contractor will be responsible for re- wiring and programming the controller back to its original state.

8. If the site contains areas of protected wetland or other environmentally sensitive areas, the Contractor shall fully acquaint himself with the actual limits of these areas and any

corresponding buffer zones, and shall make sure that the progress and/or result of his work shall not impact these areas. Generally, these areas shall not be excavated, drained, thrown into by sprinklers, used for equipment access or storage, or otherwise disturbed in any way whatsoever. The Contractor shall confirm any restrictions and react accordingly. Any fees or penalties assessed upon the Owner as a result of violations by the Contractor will be paid by the Contractor.

D. Trenching and Backfilling:

1. The Contractor shall be responsible for flagging or staking out the sprinkler head locations on the project. When grading has been established in a particular area, the Contractor shall, prior to beginning any excavation in the area, cause staking to be performed, and shall secure the approval of the Owner or Landscape Architect of the finished staking.

2. Excavation shall be open vertical construction sufficiently wide to allow free working space around the work installed, and allow ample space for backfilling and tamping. Trenches for piping shall be cut to required grade lines, and compacted to provide accurate grade and uniform bearing for the full length of the piping. Bottoms of trenches shall be free of rocks and other sharp objects. Minimum depth of cover shall be 18" on mainline piping, and 12" on lateral piping. Minimum depth of cover on low-voltage wiring shall be as provided by the electrical codes in effect. Intersecting pipes and those sharing a common ditch shall have a minimum of three inches clearance from each other, and from other utilities.

3. Initial backfill shall be pulverized native soil, free of foreign matter. Within four inches of the pipe shall be clean soil or sand. Remaining backfill shall be compacted to dry density equal to that of adjacent undisturbed soil, and shall conform to adjacent grades without depressions, lumps, or other irregularities.

4. Trench marking tape: T. Christy Enterprise, Detectable irrigation water tape.

E. Pipes:

1. Pipe and associated fittings shall be solvent-weld type. Pipe shall be installed in such a manner so as to provide for expansion and contraction in accordance with the manufacturer's published recommendations. Spigot ends of the pipe shall be firmly and completely seated in the fittings. Angular deflections in the joints shall not exceed manufacturer's recommendations. Debris shall be removed from the pipe prior to installation, and lines shall be flushed before installation of heads. Heating and bending the pipe is not permitted.

2. Pipe shall be cut in such a manner so as to provide a clean, square cut, free of chips, burrs, or splitting.

3. Pipe shall be laid using a cleaner, primer, and cement approved by Owner’s representative. 2711 gray glue shall be used for pressure lines. Blue glue shall be used for lateral lines.

4. As pipe is laid, installed pieces shall be restrained, so that slippage does not occur in previous joints. The Contractor shall monitor previous joints for slippage, until joints are set.

5. Cemented joints shall be twisted one quarter turn as they are assembled, and excess solvent shall be immediately wiped away.

F. Thrust Blocks: If solvent-weld piping is used, thrust blocks will only be required at 1) directional fittings where the surrounding soil density will not restrain the joint; 2) for all supply pipe 2-1/2” and larger in diameter. If gasketed pipe and/or fittings are used, poured-in-place concrete thrust blocks will be used on all push-on fittings. Thrust blocks will be of the size and configuration conforming to the recommendations made by the fitting manufacturer for that size and type of fitting. Thrust blocks may be formed by excavation in UNDISTURBED surrounding soil, or by forms constructed from suitable material. Fittings shall be wrapped with visqueen prior to

pouring, and wires shall not be entrapped in the thrust blocks. In no case will pre-cast blocks, cinder blocks, wood blocking, or similar unapproved methods be utilized.

G. Sprinkler Heads:

1. Sprinkler heads shall be installed on inlet-sized flex PVC swing joints. Swing joints shall be of adequate length to accommodate the piping depth. At initial installation, the Contractor shall leave the swing joints extended, and the lines shall be flushed out prior to installation of the heads. Sprinkler heads shall then be lowered to the proper level with respect to finish grade.
2. The Contractor shall be responsible for the proper adjustment of all sprinkler heads, and shall immediately inform the Owner of any head whose location or performance may interfere with the intent of the design.
3. Sprinkler heads are to be installed for head to head coverage in zones indicated on the Drawings. However, the Contractor shall be expected in the course of the work to exercise the necessary judgment to make location and type adjustments based on actual site conditions and coordination with tree locations, bed lines, or other landscape variables. No additional compensation will be given to the Contractor for changing head types, raising or lowering heads, or other work necessary due to failure to properly and completely coordinate with the landscaping work.
4. Unless noted otherwise, coverage will be provided for all new planting indicated on the Landscape Drawings.
5. The Contractor shall maintain adequate and uniform clearances between sprinkler heads and curbs, sidewalks pavement, buildings, etc., so that damage will not occur during mowing, edging or trimming operations, or from vehicle traffic. Also, proper vertical height with respect to grade and turf height shall be maintained.
6. Pop-up heads shall be used throughout the project as noted on Drawings – risers are not to be used.
7. Tree irrigation heads shall be installed within the mulch ring of the tree, at a level close to the top of the mulch, so that the head does not pose a trip hazard, and will not be damaged during mowing or other maintenance operations. Piping feeding the tree spray heads shall be installed in such a manner that no damage to the tree roots will occur.

H. Drip and Low-Volume Equipment:

1. Refer to the Drawings for installation.
2. Refer to manufacturer's instructions for installation.
3. Install the air/vacuum relief valve at approximate locations as noted on the irrigation plans and as per detail, at the highest elevation on each system. Where possible, find the most ideal location for maintenance purposes and not in easy view of the public.
4. Install the end flush valve at approximate locations noted on the irrigation plans and details. Find the most ideal location for maintenance purposes and not in easy view of the public.
5. Installation of subsurface drip system:

    A. Hard PVC pipe laterals with fittings and risers, remote control valves, drip filters, ball valves and pressure regulators shall first be installed. Next, contractor shall flush out system thoroughly. Following flushing, contractor shall install all supply tubing and end flush caps/valves, and flush the lines once more. Any single-exit drip emitters shall then be installed. Flush again.

B. Lay rolled out tubing in flat area to encourage tubing to relax from its stored form. Distribution tubing shall be cut into lengths that will allow tubing to lay in a relaxed manner from connection to connection as shown in the detail drawings. Tubing shall be given a generous amount of slack to allow for some movement. Use stakes as required to secure tubing. Provide consistent 4” cover over tubing.

C. Special precautions

1. Distance from edges: allow not more than 3 inches from the edges, particularly if it is the top edge of a slope. Edges tend to dry more easily than the center. Remember that at the bottom of a slope the distance from the edges may be larger. (see also plans).

2. Be aware of high points and siphoning: a potential problem with buried drip lines is siphoning dirt in when the system is switched off. For this reason:

   A. Drip lines should have a fairly constant slope.
   B. A vacuum relief valve should be provided at the highest point in each sector.
   C. Drip lines should be connected at the end to a common flush line with a flush valve/vacuum breaker.

3. Be aware of excessive level differences: level differences between drip lines belonging to the same valve should not exceed 6 to 8 feet.

4. Slopes: the steeper the slope, the better the horizontal movement of water in the soil. For this reason concentrate the density of the drip lines towards the top of the slope. At the bottom of the long gentle slope, the distance of the last dripper line from the edge should be as noted on plans, as water moves down due to gravity.

5. Positioning of air/vacuum relief valves: ensure that these valves are at a point high enough to prevent the system from draining through these valves when the water pressure is switched off.

D. System installation guidelines

1. It is recommended that all areas to receive subsurface irrigation shall be first excavated to a level 5 inches below proposed level of finish grade.

2. Prepare the topsoil/backfill at adjacent location to planting area to get the best water saving results with the system. For new installations, it is recommended to follow the preparation procedures described above under "special precautions". Remember that excavation and grading should have been finished before installation of the subsurface drip system.

3. Be sure everything required for the installation is present at installation site before opening trenches. Do a dry runoff assembling without gluing the system parts on top of the ground first. Pre assemble as many sets of components as practical above ground and in a convertible place. It is much easier to work above ground, so get as much work done as practical. Compression adapters should be glued to PVC tees/ells.

4. Always condition soil moisture the day before opening trenches or installing drip lines. It is much easier to install the system in moist soil than dry soil.

5. Install the system head first. Remote control valve, filters, pressure regulator and ball valve. Then install the PVC lateral lines.

6. Flush the lateral line outside the planter if practical. Connect to drip lines.

7. Distribute drip lines uniformly and as plans specify. Tubing stakes shall be installed on the tubing at the spacing of one per loop, or one every 4 linear feet. Contractor shall also mound small amounts of backfill over tubing at intervals to set tubing.

    a. Select the tentative distance between drip lines. (say "number" of inches)

    b. Measure the exact dimension of the area to be covered leaving 3 inches for the edges. (is area width minus 3" each side of planter = exact width of area tubing is to be placed)

    c. See how many spacings can actually be left. (area width divided by the designed tubing spacing (say 18" for example) equals the number of rows of tubing required, adjusted for nearest distance of tubing spacing designed for).
    d. Recalculate what the new revised distance between drip lines should be to divide the space evenly.

    e. Stake where the beginning and flush end of each drip line will go.

8. Tubing installation: leave enough length at the beginning and end for connections. It is convenient to finish the last foot of the installation or trench by hand. This gives more room for connections. Beware of bending the drip tubing too tight during installation. Do not bend tubing below a 24 inch radius because the pipe may kink, reducing the flow. Use compression type elbows and fittings whenever required. Use a template (for example, such as a 5 gallon bucket) for forming bends or for spacing lines as required to maintain uniform line spacing. Install tubing stakes at a 5 foot maximum spacing along each tube, more as required on curving sections.

9. The systems shall be left open and tubing and emitters left uncovered for testing purposes by the landscape architect. After successful testing of systems, cover system with prepared backfill previously set aside. Cover tubing early in the morning when temperatures are low to avoid tubing stress.

10. Warning: drip line is temperature sensitive. The protective life of the system will be reduced if the drip line outside is exposed to the sun for a long period of time. Store the drip line in a cool shaded place until installed.

11. Ensure equal and uniform distribution of water to all plantings in various sizes of planter pots. No drip tubing shall be allowed to be exposed, provide good bury depth

I. Electrical Wiring:

1. Any wire splices which cannot be practically made in a valve box or controller cabinet shall be housed in a splice box, and appropriately labeled.

2. All electrical work shall be performed in such a manner so as to conform to any and all prevailing building codes and regulations, and by persons whose qualifications and licensure are consistent with same.

3. Wire shall be buried in the ground at depths and clearances as noted on Drawings, and shall be snaked in the trench to allow for expansion and contraction. All wiring shall be color-coded as prescribed hereinbefore and on the Drawings, bundled at ten foot intervals, and identified at 150' intervals.

4. Low voltage wiring shall be installed with adequate slack and surge/ expansion loops. Use Spears "Dri-Splice" connectors and sealant. The use of "DBY" type connectors, or other removable types shall not be permitted without prior approval. A minimum of one spare wire shall be run from the last valve in each direction to the controller location(s).

5. Unless otherwise noted, it shall be understood that power feeds to the controller and shall be furnished by the Electrical Contractor, but that connection to the equipment shall be the responsibility of the Irrigation Contractor.

J. Lightning Protection:

1. The Contractor shall furnish and properly install all applicable lightning protection devices for the control system, and shall see that the system is prepared for operation in a lightning-intensive environment. This equipment shall include (for each controller), but not be limited to, an approved 3-wire type 120-VAC primary arrestor, such as the Intermatic #AG2401, and controller valve output protection on the individual zone circuits, if not already included internally in the controller circuit.

2. In addition to the bonded ground wire installed with the power wiring, the Contractor shall provide at each field controller location an earth ground, having a measured resistance to earth of ten ohms or less. Ground resistance shall be measured and approved by a representative of the controller manufacturer, or by an independent tester mutually agreed upon by the parties, and paid by the Contractor. The use of grounds shared with other equipment, power supply grounds, building structure grounds or cold water piping shall not be acceptable for the discharge from the arrestor equipment.

3. Each grounding unit shall consist of a minimum of two 8'x 5/8" copper-clad iron electrodes, installed coupled and stacked one on top of the other. If this does not result in an acceptable ground resistance level, the Contractor shall negotiate with the Owner to improve the grounds by further stacking or gridding of additional rods, or by running a minimum of 150' bare copper wire into the irrigated area, and staking a rod at the end. The latter method should be done by trenching, or by plowing in a snaked pattern and pulling tight, to imbed the wire in the earth on either side of the puller hole.

4. Wire for grounding electrodes shall be solid bare copper, of the same size or larger than the largest power or neutral wire feeding the location. Minimum size for ground wire shall be #8AWG. Grounding wire shall be connected to the rods with suitable copper-clad or brass grounding clamps, and separate clamps shall be used for each wire being connected.

K. Automatic Control System:

1. All components of the Calsense control system shall be installed in a manner consistent with the Drawings, and with the recommendations made by the manufacturer of the equipment.

2. Controller locations shall be determined using the Drawings as a guide, but shall be coordinated and confirmed in the field with the owner’s representative.

3. Install rain sensor enclosure assembly onto controller enclosure, drill hole and hook up sensor wires to controller terminal strips. Make waterproof all penetrations with installing this sensor assembly.

4. The Contractor shall make sure that controller cabinets are properly sealed to keep out weather and pests.

5. No modifications shall be made to the controller equipment which may adversely affect the product warranties.

6. The Owner's designated operations personnel are trained in the operation and programming of the computer control system. Initial set-up and programming of any new controllers shall be performed by the Owner’s representative, based on recommendations by the Owner’s

representative. Contractor shall coordinate watering program input with Owner's Representative throughout project construction and before irrigation system will be considered for final acceptance.

7. Each controller shall be furnished with a legible laminated diagram created from the as-built, showing a sketch of the area for all valves covered by the controller along with the square footage for each valve zone, and the locations of all RCV valves, ball valves, wire boxes, sleeve location, controller and backflow. This diagram shall be affixed to the inside of the controller door.
8. The control wires from existing-to-remain control valves shall be connected to the terminal strip at the controller. Provide station programming for these stations along with all new systems connecting into the controller. The installation of the wiring inside the controllers shall be clean and neat, with slack left coiled and tied. Extra wires shall be wire-nutted and moved aside, they shall be labeled as "spare". The wiring shall be arranged in such a manner that the controller panel remounts easily without being "stuffed" back into the cabinet. The Owner reserves the right to correct unsafe or unserviceable wiring and back charge the Contractor.
9. Wire nuts used for connections within the cabinet shall have metallic threads. Those with plastic threads are unacceptable.
10. All unused accessories, hardware and paperwork furnished with the controller(s) shall be turned over to the Owner, and a minimum of two (2) cabinet keys shall be furnished.
11. Contractor shall coordinate with Owner's Representative for programming watering times and scheduling watering events. Provide ongoing coordination with Owner's Representative for any adjustments throughout construction.

L. Valves:

1. Install no more than one valve per box.
2. Install valves in locations where not easily visible by the public. Coordinate all proposed locations with the Owner to obtain approval prior to installation.
3. Valves shall be installed in manifolds with up to four (4) remote control valve boxes. Provide a minimum fifteen feet (15') separation between manifold locations to allow for plantings to separate multiple valve box manifolds. Coordinate manifold size and exact locations of all valves and valve boxes with Owner prior to any installation.
4. Zone control valves and ball valves shall be installed in valve boxes as described in Products Section and in the Details.
5. All valves and valve boxes shall be installed plumb and at the proper height with respect to grade, having a minimum clearance from handle to closed valve box lid of no less than 3".
6. All valve boxes shall be surrounded with commercial grade filter fabric to enclose valve box assembly to keep soil and other solid materials outside of valve box pit.
7. Valve boxes shall be lined at the bottom with a layer of pea gravel.
8. All assembly bolts and stem packings shall be checked for proper tightness, and the valves shall be visually checked for leakage both during operation and non-operation.

M. Valve Boxes:

1. Set boxes 12" apart.
2. Install no more than one valve per box.

3. Install valve boxes where not easily visible by the public. Coordinate all proposed locations with the Owner to obtain approval prior to installation. and screened with surrounding plant material.
4. Valve boxes shall not be modified in any way by cutting away portions thereof, in order to ensure their structural integrity. Any removal of valve box material will be subject to rejection and replacement, unless such removal is granted by the Owner, but only under consideration prior to valve box installation.
5. Contractor shall replace damaged valve boxes and valve box lids of existing-to-remain valves as required. Partial replacement parts shall be of same manufacturer and model as existing. Replace with matching parts, including colors of parts.
6. All valve assembly components shall be checked for tightness and shall not exhibit leaks.
7. All assembly bolts and stem packings shall be checked for proper tightness, and the valves shall be visually checked for leakage both during operation and non-operation.
8. Heat brand on top of valve box lid to 1/8” depth with 1-1/2” to 2” height text, readable from side valve would be accessed. Size shall be consistent throughout the project.
9. Heat brand controller number and valve station number for remote control valves. Heat brand other box lids as: “BV” for ball valve, “PB” for pull box, “SW” for spare wires, “WS” for wire splices, “ML” for mainline stub-out, “FS-XX” for flow sensor (XX designation relating to controller designation), “QCV” for quick coupling valve, “CV” for in-line check valve, “AVR” for drip air vacuum relief valve, “FV” for drip flush valve, etc.
10. Where valve boxes are to be adjusted to new finish grade following grading operations, utilize valve box extensions to match existing valve box manufacturer/model.

N. Road Crossings:

1. Exact locations of road crossings shall be determined on-site. As long as resulting depth will be in accordance with applicable codes, the road crossings shall be buried to a depth equal to the mainline piping, so no offsets will be required in the main. Absolutely NO cutting of pavement or soil cement will be permitted without the prior approval of the Owner.
2. Sleeves shall be sealed at each end after all utilities are run through. All sleeves to utilize wire shall be installed with pull rope inside, with sufficient length coiled and secured at each end.
3. If road crossings have been installed by others, the contractor shall verify the existence and location of same at his earliest involvement in the project, and shall advise the Owner's Representative IMMEDIATELY if a required sleeve cannot be located or is undersized, damaged, too short, obstructed or otherwise unusable.
4. The locations of all sleeves used by the Contractor shall be marked on the curbs in a permanent but unobtrusive manner to be agreed upon by the parties, and a valve box installed with 6” vertical piping on both sides and shall be shown with accurate measurements on the "As-Built" Drawings. This shall be done even if the sleeves were installed by someone other than the Contractor.

3.03 TESTING AND INSPECTION:

A. On-Site Inspections:

1. At any time during the work, the Owner or his designated Representative may visit the site to make official inspections. The Contractor may or may not be notified prior to the inspection, at the discretion of the Owner.

2. Upon request, the Contractor shall be required to uncover specified work as directed by the inspector, without further compensation.

3. Should the work not meet the standards specified herein or required by codes, the Contractor will be directed to replace the work at his expense.

B. Testing:

1. Pipeline testing shall be done as work progresses. Hydrostatic tests will be performed in the mainlines and witnessed by the Owner's Representative. The Contractor may elect to perform the test prior to installation of the zone valves, and the system mainline network may be tested in sections or as a whole. The test pressure shall be 100 PSI, which shall be maintained for a period of not less than one hour.

2. The lateral lines under pavement shall be hydrostatic tested prior to installing complete irrigation systems and lines backfilled. Leave all joints exposed for review.

3. All other piping will be inspected visually for leaks. The Contractor shall promptly repair any leaks found, and any subsequent damage, at no cost to the Owner.

C. Adjustment of System:

1. The Contractor shall balance and adjust all components of the system so that they are operating at optimum levels of performance and efficiency.

2. At such time as designated by the Owner, the Contractor shall return to the job and readjust the heights of sprinkler heads to conform with the finished sodding and planting.

D. Final Inspection:

1. Within ten days of completion of the work under this contract, the Contractor shall notify the Owner's Representative, who shall schedule a meeting on-site of all interested parties, for the purpose of making a final inspection of the system.

2. The Contractor shall demonstrate the system, and his conformance to the Drawings, Specifications, and all subsequent addenda.

3. If any work proves incomplete or unacceptable, a punch list shall be prepared, and all work required shall be performed by the Contractor to the satisfaction of the Owner before the work can be considered acceptable.

4. The Contractor is expected to know his responsibilities under this Contract, and shall see that all work is complete before requesting the inspection. Repeated or otherwise useless inspections resulting in extra cost to the Owner, and brought about due to by the failure of the Contractor to complete the work or react to punch lists in a timely fashion may result in chargeback’s to the Contractor.

E. Irrigation System Audit: Contractor shall have an irrigation audit performed by a certified irrigation auditor or certified water manager certified through the Irrigation Association to assure proper operation, coverage and water conservation of all newly installed systems. Refer also to Submittals Section.

3.04 WARRANTY

A. Warranty Duration:

1. The Contractor shall submit a guarantee, for one year from final acceptance, against defects and malfunctions in the equipment, and against faulty workmanship. This shall be exclusive of any extended warranties which may be in force from the various equipment manufacturers.

B. Required Information:

1. The guarantee shall state the name of the Owner, provide full guarantee terms, effective dates, name of the Contractor, and his address and telephone number. It shall be signed by the chief executive of the company and notarized.

END OF SECTION

SECTION 329300

EXTERIOR PLANTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work Included: The Landscape Contractor (LC) shall provide all labor, materials, plant materials, topsoil, equipment, services, and facilities required to complete all landscape planting and related work, as indicated on the drawings, as specified herein or both, except as for items specifically indicated as “NIC ITEMS”.

B. Maintenance: The work shall also include the maintenance of all plants and planting areas until the receipt of final acceptance, in writing from the Owner, and the fulfillment of all guarantee provisions as herein specified.

C. General Requirements: All applicable provisions of the Bidding and Contract Requirements, including General and Supplementary Conditions, and Division 01 - General Requirements, shall apply to the work under this section.

D. Related Work: The work to be performed under this specification section must be coordinated with the requirements of all site related sections which include, but are not limited to:
   1. Section 24119 Selective Demolition
   2. Section 310000 Earthwork
   3. Section 321300 Concrete Paving
   4. Section 328400 Irrigation
   5. Section 329600 Existing Tree Protection, Transplanting & Root Pruning

E. Protection of Public & Property: The LC shall, at all times, protect all materials and work against injury from any cause, and shall provide and maintain all necessary guards for the protection of the public. The LC shall be held responsible for any damage or injuries to persons or property that may occur as a result of his/her fault or negligence during the execution of the work. The LC shall ensure that his work does not interrupt established or projected drainage patterns.

F. Change Orders: Any change or substitution in the landscape work must be negotiated between the LC and the Owner or Owner’s Authorized Representative (OAR). Any work performed on changes or ‘extras’ prior to execution of a written agreement may or may not be compensated for by the OAR at his discretion.

G. Contractor shall notify the project Landscape Architect and the Owner for observation at the following times:
   1. Pre Construction Meeting – Refer to Section 010300
   2. Mainline – Prior to backfill and pressure test
   3. Lateral lines – Prior to backfill
   4. Control Wires – Prior to backfill
   5. Tree Locations – Prior to Planting
   6. Irrigation Coverage – Prior to Plant Placement
   7. Plant Approval and Spotting – Prior to Planting
   8. Pre-Final Walkthrough
   9. Final Approval

H. The Contractor shall be held responsible for any repairs made necessary through the actions or negligence of his employees and subcontractors.

1.02 PLANTING LAYOUT

A. Site Familiarity: Prior to beginning work, the LC shall familiarize themselves with the existing conditions within the project site. Site observations shall include, but is not limited to, field verification of:
   1. Site Utilities: The existence and location of all underground utilities in order to take adequate precautions to prevent damage, disturbance or service interruption. It shall be the responsibility of the Contractor to obtain all such information as it is made available. Plans and specifications of related work may be obtained from the Owner.
   2. Site Irrigation: The existence and location of all underground irrigation in order to take adequate precautions to prevent damage, disturbance or service interruption. It shall be the responsibility of the Contractor to obtain all such information as it is made available. Plans and specifications of related work may be obtained from the Owner. It is understood that scope of new construction will require demolition of a portion of the existing irrigation system. LC must take required actions to keep portion of system to remain operational throughout the period of construction. This will require temporary installation or system modifications to maintain service to planter areas outside the limits of work that are serviced by connected zones or controllers. All temporary adjustments are the responsibility of the LC and are to be considered in the base scope of work.
   3. Reference Points: Upon the initiation of work the LC shall locate and establish all general reference points and benchmarks to be used for horizontal and vertical layout. The LC shall take precautions to prevent their disturbance while performing the layout and installation work and will be responsible for all lines, elevations and measurements of work executed under the contract. The LC shall exercise proper precaution to verify figures on drawings before laying out work and will be responsible for any error resulting from failure to exercise such precaution. The LC shall make field measurements of existing and/or as-built conditions for his own work and be responsible for its accuracy.

B. Site Discrepancy: Discrepancies between conditions existing on the site and conditions indicated on the drawings shall be called to the attention of the Owner before or at the time plant locations are staked out. LC should notify the Owner of any site condition(s) they believe could have an adverse affect on the plant materials ability to thrive.

C. Material Discrepancy: In the event of a discrepancy between the material quantities shown on the plant schedule and the number of plants indicated on the plans, the plans shall control. The LC shall verify, furnish, and install all of the plants required to complete the work shown on the drawings and in the specifications at no additional cost. Any discrepancies found between the plans and the plant list shall be noted at the bottom of the bid submittal, so that an accurate quantity can be incorporated into the final contract.

1.03 HORTICULTURAL STANDARDS & GOVERNMENT STANDARDS

A. All current government codes, standards or regulations shall be followed in executing this contract, including the City of San Diego Landscape Manual and Water Conservation Ordinance.

B. Grades & Standards: Unless otherwise noted, plant material, including collected materials, shall exceed and be in accordance with quality standards set for by the California State Department of Agriculture's regulation for nursery inspections, rules, and grading. Also, shall conform to American Standard for Nursery Stock, ANSI (American National Standards Institute, Inc.) Z60.1-2004 as approved by the American Association of Nurserymen.

C. Plant Identification: All plant names shall conform to the names given in Sunset Western Garden Book, 2012 edition. Names of varieties not included therein shall conform generally with names accepted in the California nursery trade. All plant materials shall be true to botanical, common and variety name. Botanical name shall have precedence over common name. Also, names shall conform to Standardized Plant Names, 1942 Edition, prepared by the American Joint Committee on Horticultural Nomenclature.

D. Quality Control: The Owner reserves the right to monitor the quality of the landscape materials to be incorporated into the project via any of the mechanisms listed below or combination thereof:
   1. Owner shall have the right, at any stage of the operations, to reject any and all work and materials which, in his opinion, do not meet with the requirements of these Specifications. Such rejected material shall be removed from the site and acceptable material substituted in its place.
   2. Source Quality Control:
      a. The LC shall ship all landscape materials to the job with appropriate California State Department of Agriculture, Bureau of Plant Industry, and Certificates of Inspection.
      b. The LC shall provide trees and shrubs grown in a licensed nursery in accordance with standard horticultural practices.
   3. Inspection: The Owner reserves the right to inspect plant materials either at place of growth or at the site prior to planting to ascertain compliance with requirements for name, variety, size, and quality. Final approval shall be based upon the in-place inspection. Any plants that are not in compliance shall be removed and replaced at the LC's expense.
   4. Substitutions:
      a. No substitutions will be allowed, unless the Owner is first notified and written approval is received. Written documentation regarding all substitutions will be required at the time of substantial completion.
      b. If the specified or detailed landscape materials are not obtainable, LC shall provide the Owner with a written proposal for use of equivalent material.
   5. Testing Agencies:
      a. The LC shall perform soil testing services using an agricultural testing laboratory certified in the State of California.
      b. Test reports: The LC shall submit all test reports and other certified statements of test analysis.
   6. Project supervision: The LC shall have labor crews controlled and directed by an experienced supervisor well-versed in reading blueprints and specifications pertaining to landscape installation and maintenance. NOTE: A supervisor shall have current plans and specifications readily available on-site at all times.
   7. The Owner reserves the right to delegate the responsibility of monitoring plant material to an authorized representative.

1.04 CERTIFICATES OF INSPECTION

A. All plant material shall be inspected by the California Department of Agriculture, as required by state law. Plants of a grade less than that specified in the article titled HORTICULTURAL STANDARDS will not be accepted.

1.05 SUBMITTALS

A. Review and Approval: All submittals shall be submitted by the LC to the Owner a minimum of two (2) weeks prior to the installation of any of the materials. The LC shall not begin work until all submittals have been approved by the Owner.

B. Installation Schedule: The LC shall submit to the Owner for approval, a planting installation schedule showing dates for starting and completing each type of planting in each area of the site.

C. Samples: The LC shall submit to the Owner for approval, samples of organic amendments to the LA and OAR accompanied by analytical data.

D. Warranties, Certificates, and Inspection Tags:
   1. The LC shall submit warranties, certificates, and inspection tags to the Owner for all products and materials.
   2. The LC shall submit certificates of inspection for all materials and products subject to state or federal governmental inspection to the Owner.

E. Test Reports and Recommendations: The LC shall provide analysis and percolation testing of existing soils with samples from the site and planting soil supply areas obtained from a certified soils testing laboratory (i.e., signed original copy(s) by testing laboratory only).

F. Maintenance Instructions: Prior to final approval, the LC shall furnish three (3) copies of written maintenance instructions to the Owner for maintenance of the installed plants throughout their full-growing season.

G. Documentation of Plant Availability: Prior to commencing work and procuring plant material, the LC shall provide the Owner with written documentation that all of the plant materials can be supplied as specified within the timeframe designated by the Owner. The LC shall verify that the nursery sources, quantities, size, and specimen quality for each plant specified can be provided. If specified plant material is not obtainable, the LC shall submit written notice of non-availability together with a proposal to the Owner for an equivalent substitution. Under no circumstances shall any substitutions be made without the prior written approval of the Owner.

H. Schedule to Field Tag Plant Materials: If requested, prior to procuring plant material, the LC shall coordinate and make all arrangements with the Owner to visit the nurseries for the purpose of selecting and tagging the specified plant materials. The LC shall schedule the field visits at times convenient to all parties with reasonable written notice and confirmation provided.

I. Plant Samples: If requested, the LC shall provide three (3) plants of each shrub, ground cover, or as specified for approval by the Owner and to be used as the representative size, specification, and plant type for all plant materials to be installed. Any plant materials that do not conform to the plans, specifications, or approved plant samples shall be rejected.

J. Plant Photographs: Electronic photos in JPEG format of each size and species of Shrub, Groundcover and Vine, flat, 1gal, and 5 gal size. Photos shall be an accurate representation of the actual Shrub, Groundcover and Vine specimens to be utilized on the project. Photos shall be transmitted to the Landscape Architect via e-mail and/or other electronic media. Identify each photograph with the full scientific name of the plant (genus, species, variety, cultivar, etc), plant size, and name of the growing nursery (under separate text if needed). Include a scale rod or other measuring device in each photograph. For species where more than 10 plants are required, include a minimum of three photographs of that species showing the average plant, the best quality plant, and the worst quality plant to be furnished.

K. Fertilizer(s) sources, types, formulas, and application rates.

L. Plant Samples and/or Photographs: If requested.

M. Samples of Mulches: 1-gallon bag of rubber mulch.

N. Staking and Guying Methodologies: Provide manufacturer's product literature, if different from that specified.

O. Specifications and addenda:
   1. The LC shall legibly mark each section to record changes made by Clarification, Field Order, and/or Change Order.
   2. The LC shall procure from the Owner one (1) complete AutoCAD digital file (if available) of the project's landscape construction documents to be used for record drawing documentation. The LC shall transfer all record documents information outlined above from the reproducible prints to the digital AutoCAD file on separate layers according to the CADD Standards established by the Architect. The LC shall submit the digital file and one (1) set of prints to the Owner upon completion of the project.
   3. "As-Built" record drawings shall be kept updated weekly by the LC and shall be reviewed by the Owner during the course of the work. If during the course of the work, the record drawings are found substantially incorrect or substantially behind the progress of the work, the Owner shall have the right to hold progress payments until said drawings are brought to an acceptable

level of completeness.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Preparation for Delivery:
   1. The LC shall prune all heads and/or roots of all trees only under the direction of the Owner, and as required to assure safe loading, shipment, and handling without damaging the natural form and health of the plant. In no case are trees to be topped.

B. Delivery:
   1. Packaged materials: The LC shall deliver packaged materials to site in original, unopened containers showing:
      a. Weight;
      b. Analysis;
      c. Name of manufacturer;
      d. Trade name or trademark; and
      e. The LC shall protect from deterioration, contamination, adverse weather, and other damage.
   2. Plant materials: Upon delivery at the site, all plants shall conform to specifications and be checked for handling damage by the LC. Any required inspection certificates, tags, or labels shall accompany each shipment and shall be provided to the Owner by the LC.
   3. Planting soil mix and mulch: The LC shall deliver approved planting-soil mixes, cobble, and mulch in bulk with manufacturer's guaranteed mix, name, and conformance to State law. The LC shall store these materials in designated areas approved by the Owner.

C. Storage:
   1. The LC shall protect plants upon arrival on-site from drying or possible injury.
   2. The LC shall thoroughly water and properly maintain until planting.
   3. The LC shall not allow plants to remain unprotected for a period exceeding four (4) hours. The LC shall store plants in the shade and protect them from weather.
   4. The LC shall heal-in trees in a vertical position so that the tree canopy or fronds are not touching the ground.

D. Handling:
   1. The LC shall exercise all methods customary in good and industry standard horticultural practices.
   2. The LC shall not drop plants nor use chains or cables on any trees. The LC shall handle trees using nylon straps with a minimum width of four inches (4").
   3. The lifting points on all equipment shall be wrapped to prevent trunk or limb damage when lifting plants.
   4. The LC shall remove from the site all plant materials that are not approved, and replace with plant materials that are in accordance with the plans and specifications.

1.07 PROJECT CONDITIONS

A. Existing Conditions:
   1. The LC shall examine the project site, verify elevations, observe the conditions under which the work is to be done, and notify the Owner of any unsatisfactory conditions.
   2. The LC shall not proceed with work in this section until conditions have been corrected satisfactorily.

B. Utilities:
   1. The LC shall determine the location of surface and underground utilities.
   2. The LC shall exercise care in digging and other work so as to not damage existing work including underground cables and pipes.
   3. Should such underground obstructions be encountered, which interfere with his work, the LC shall notify the Owner immediately.

4. The LC shall be responsible for the immediate repair of any damage caused by his work and will be responsible for any disruption of service caused by this damage. Patching and replacing damaged work will be accomplished by the Owner's designated Contractor and the cost of this will be paid by the LC.
5. The LC shall maintain grade stakes set by others until removal is approved by all parties concerned.

C. Excavations: When conditions detrimental to plant growth are encountered, such as rubble fill, road sub-base, adverse drainage conditions, or obstructions, the LC shall notify the Owner OAR immediately prior to planting.

D. Protection:
1. The LC shall protect and maintain, as part of the work of this section, all existing plant materials (if applicable).
2. The LC shall verify that all existing trees to remain (if applicable) are properly identified and barricaded to prevent damage by their work under this and future construction. The LC shall be responsible for maintaining adequate identification and barricading of all existing plant material to remain throughout the installation and required maintenance period.

E. Sequencing and Coordination:
1. Prior to all work, the LC shall coordinate the work of this section with related work of other trades, and inform the Owner of any scheduling or other discrepancies relating to work to be performed.
2. The LC shall notify the Owner of anticipated installation phases and date(s) at least (2) two weeks in advance.
3. Prior to the starting of planting, the LC shall verify that the underground irrigation system and finish grading have been approved. Unless specified otherwise, the LC shall not commence planting until:
    a. Site grading, soil import, and soil testing and preparation has been completed and approved.
    b. Substantial provision for irrigation or hand watering has been provided to maintain plant materials.
4. The LC shall proceed with, and complete the landscape planting work, as rapidly as portions of the site become available or as otherwise directed.
5. The LC shall protect all materials and work against injury from any cause and will provide and maintain all necessary safeguards for protection of the public. The LC shall be held responsible for any damage or injury to person or property that may occur as a result of his/her negligence in the prosecution of the work.
6. The LC is responsible for maintaining accepted finish grades until Final Acceptance by the OAR and LA.

1.08 WARRANTIES

A. Shrubs and Ground Cover: As per item 3.19, the LC shall warrant shrubs and ground cover in writing for a period of three (3) months beyond the date of Final Acceptance.

B. Trees and Boxed Materials: As per item 3.19, the LC shall warrant trees and boxed materials in writing for a period of one (1) year beyond the date of Final Acceptance.

C. Fertilizer:
1. The LC shall affix to each container of fertilizer used in connection with this work, the manufacturer's certified analysis tag or label.
2. Fertilizer analysis shall be:
    a. No less than minimum requirements of the specifications.
    b. As guaranteed by requirements of the California State Fertilizer Law.

D. Peat/Humus: The LC shall certify in writing that the peat/humus used meets all requirements and criteria of the specifications.

E. Warranty Conditions: In addition to prior specified warranty conditions, warranties are to cover defects (including death and unsatisfactory growth), except for defects resulting from neglect by Owner, a result of malpractice carried out by the Owner, abuse or damage by others, or unusual phenomena and incidents which are beyond the installer's control.

F. Replacements:
   1. At any stage of the planting installation operations or during the warranty period, any plant material covered under this contract that is dead or showing indication of probable non-survival or lack of health and vigor, or which does not exhibit the characteristics and conditions, such as to still qualify for the minimum grade as originally specified, will be promptly replaced by the LC. Replacement plants shall be installed as soon as possible and maintained per the specifications for the planting of new plant material, as well as warranted as specified above, for new plant material.
      a. The LC shall perform all necessary watering, over and above that provided by the automatic irrigation system, which is necessary to establish replacement material.
      b. Cost of the repair for damage caused by the LC to items including, but not limited to, other plants, lawn, curbing, walks, roads, etc. will be the responsibility of the LC.
      c. The LC shall coordinate replacements with the Owner.
      d. The LC shall make replacements during the growing season following the end of the warranty period, or as otherwise mutually agreed with the Owner.
      e. The LC shall furnish and plant replacements that comply with all requirements indicated and specified for original material.
      f. The LC shall replace trees and shrubs that are in doubtful condition at the end of warranty period, unless the Owner finds it advisable to extend the warranty period.

G. Guaranteed Proving Period:
   1. There shall be a guarantee and warranty period of 1 year for trees and specimen material and 3 months for shrubs. This guarantee and warranty period shall start at the final acceptance date. Contractor shall replace any and all plant material that die during this guarantee proving period. Replacement of plants necessary during the guarantee period shall be the responsibility of the Contractor, except for possible replacements of plants resulting from removal, vandalism, acts of neglect on the part of others, or acts of God. All replacement material shall have the same guarantee time (1 year from installation of replacement for trees and specimen material and 3 months for shrubs).
   2. Planting maintenance shall include all necessary watering, cultivation, weeding, pruning and spraying; wrapping and mulching; straightening of plants which lean or sag and which develop more than a normal amount of settlement; such adjustments to include excavating around and leveling or raising the ball when so directed; and all other incidental work necessary for proper maintenance as directed by the Owner until substantial completion and written release.
   3. Transplanted material (if applicable) shall not be guaranteed, however, good horticultural practices should be used before, during and after the material is transplanted. Good horticultural practices should include but not be limited to, all necessary watering, pruning and spraying; wrapping and mulching; fertilizing; moving; maintaining the same orientation and grade level from the original location; and all other incidental work necessary for proper transplanting.

1.09 METHOD OF MEASUREMENT

A. Quantities: The quantities given in the plant list are approximate only, and the LC shall verify, furnish, and plant all plants required to complete the work, as shown on the drawings and in the specifications at no additional cost.

B. Measurement:
   1. Trees, shrubs, and ground cover will be measured for payment on the basis of each plant installed complete, in place, and accepted. The types and sizes of plant material will be measured separately.

2. Associated products, equipment, and execution necessary or incidental, thereto, will not be separately measured, but will be considered as included in the measurement for trees, shrubs, and ground cover.

C. Payment: Final payment will be made when the following documents are presented to the Owner:
   1. Release of lien: The LC shall furnish the Owner with release of liens from all suppliers, as well as furnishing any liens by subcontractors to the LC doing work on this project. The LC shall provide the Owner with a release of lien prior to final payment.

PART 2 - MATERIALS

2.01 GENERAL

A. All chemicals used shall be approved by the owner prior to delivery to site.

B. All chemicals and products shall be registered by the State of California Department of Food and Agriculture and the Environmental Protection Agency with registration identification on the label. Label shall be at job site at all times.

C. All chemicals and products shall be applied as per registered label instruction and manufacturer's recommendations.

D. Chemicals and products requiring a licensed applicator must be applied by persons registered with the Department of Agriculture's Commissioner's Office as possessing a current, valid, qualified pest control applicator's license and or state/local government agency.

E. The use of any restricted materials is forbidden.

F. All products shall be non selective, translocative and approved by owner prior to application.

2.02 IMPORT SOIL

A. Existing site soil shall be used as topsoil for mounding purposes when possible. It shall be free of debris, weeds, or other foreign matter. Contaminated soil shall be removed and replaced with acceptable soil (either site soil or import soil).

B. Import Soil: Shall conform to ASTM D 5268, pH range of 5.5 to 7.4 percent organic material minimum. It shall meet additional criteria as follows:
   1. Fertile, friable sandy loam texture having a normal amount of humus.
   2. Silt plus clay content shall not be greater than 15% by weight.
   3. Boron content shall not be greater than 1 part per million as measured on the saturation extract.
   4. Sodium absorption ratio (SAR) shall not exceed 3.0 milliohms per centimeter at 25 degrees C
   5. Free of roots, rocks larger than ½ inch diameter, weeds brush and nematodes.

C. Samples of imported soil shall be submitted to an agronomic soils testing laboratory. Test results shall be delivered to the Owner or OAR for approval before being delivered to the project site.

2.03 PLANTING MIX

A. Topsoil / Planting Mix backfill to be as follows: Top dress all planting areas with 12 inch depth of Special Mix #1A Topsoil available from Hanson Aggregates 858-577-2727 or Owner approved equal.

B. Other Amendments – Where new topsoil cannot be added in areas around existing trees or shrubs to remain, then these areas shall be amended with compost, a balanced fertilizer approved by owner to a depth of 12 inches. Additional amendments that may be required due to the soils analysis:
   1. Iron Sulfate – 20% Iron by volume. WARNING: Fertilizers containing chelated iron will stain concrete surfaces. The Contractor shall take care not to stain concrete and shall be responsible for removing all iron stains from concrete, at no additional cost to the Owner.

2. Gypsum – Commercially packaged, free flowing gypsum containing not less than 95% by volume of calcium sulphate as active ingredient.
3. Soil Sulphur – Agricultural soil sulphur, 90% elemental minimum.
4. Wetting agent – Naiad, EZ Wet by Grow More or equal.

2.04 FERTILIZER

A. Mix Design: Specific fertilizer chemical mix shall remedy nutrient deficiencies noted in the soils analysis. The LC shall provide a complete commercial fertilizer mixture complying with the laws of manufacture regulating the sale and manufacture of fertilizer in the State of California.
   1. Pre-plant Fertilizer shall be a slow release (60-20-20) commercial, dust free homogeneous pellet fertilizer. "Best" or approved equal.
   2. Post-plant Fertilizer shall have 5-3-1 NPK analysis with 50% humus, humic acids, soil strain bacteria, micronutrients, and 1% soil penetrant. "Gro Power Plus" or equal.

2.05 PLANTING TABLETS

A. Use Agriform (20-10-5) blue chip tablet. 21 gram size for trees and shrubs, 5 gram size for flat plants

2.06 PRE-EMERGENCE WEED CONTROL

A. Weed control shall be Ronstar 2G as manufactured by Bayer Environmental Science, Canada, Telephone 888.283.6847, www.bayeres.ca, or an approved equal.

2.07 WATER

A. Water will be available for use on site during the landscape installation at no cost to the Contractor. Care shall be exercised to assure that water is kept free of harmful chemicals, acids, alkalies, or any substance that might be harmful to plant growth.

2.08 ANTIDESICCANT

A. Antidesiccant shall be an emulsion type, film-forming agent designed to permit transpiration, but retard excessive loss of moisture from plants, such as Dowax by Dow Chemical Co., or Wilt-Pruf by Nursery Specialty Products, Inc., or an acceptable equal. The antidesiccant shall be delivered in the manufacturer's fully identified containers and shall be mixed in accordance with manufacturer's instructions.

2.09 MULCH

A. Manufacturer: NuPlay

B. Product: Rubber Mulch Nuggets

C. Color: Earthtone

D. Quantity: Area as indicated on drawings, 3" depth

2.10 STONE MATERIALS

A. White gravel rock, 3/4"-1". Samples to be reviewed and approved by Owner and Architect prior to installation. Final producet shall be similar to material sourced by KRC Rock.

B. Black lava rock, 3/4" – 1". Samples to be reviewed and approved by Owner and Architect prior to installation. Final producet shall be similar to material sourced by KRC Rock.

2.11 GUYING AND STAKING MATERIAL

A. Stakes shall be of lodge pole pine. These shall be straight shafts, shaved and cut clean and bare of branches and stubs, of uniform thickness with a minimum diameter of 2 inches, free of loose knots, splits or bends. Stakes shall be no less than (10) feet in length.

B. Tree ties shall be V.I.T. Cinch Tie or approved equal.

1. ATG-R for up to 4” caliper trees: (3) Polypropylene guylines ¾”x12’=800 lb test, olive drab, UV resistant; (3) nickel plated spring cam-lock tensioning clips; (3) arrowhead nylon anchors (4”x3-3/4”).
2. ATG-J for up to 6” caliper trees: (3) Polypropylene guylines 1”x12’=1000 lb test, olive drab, UV resistant; (3) 1-1/4” nickel plated, non-rusting, spring cam-lock tensioning clips (1500 lb break strength; (3) arrowhead nylon anchors (5-1/2”x4-1/2”).

C. Plastic ribbon for identifying wire shall be ½” wide tied at 18” intervals. Color: white.

2.12 ROOT CONTROL BARRIERS

A. Root control barriers shall be provided between paving and canopy trees at a minimum depth of 24 inches for a length of 10 feet minimum or owner approved dimensions.

B. Root control barriers shall Deep Root, Model UB 24-2, 24” high x 24” wide panels. Available thru Deep Root Partners (800) 458-7668, info@deeproot.com

C. Root barriers shall be as follows:
1. 15 gallon trees: #UB24 – two with 4 panels required.
2. 24 inch box trees: #UB24 - two with 5 panels required.

2.13 SOIL SEPARATION MATS/FILTER FABRIC

A. Soil separation mats, shall be Christy’s 3.0 oz Polyspun Landscape Fabric available from tchristy.com 800-258-4583 or approved equal. Contractor shall also bid and submit Mirafi 140N, as manufactured by Mirafi (or equal), 3500 Parkway Lane, Suite 500, Norcross, GA 30092, phone 800.234.0484 for comparison. Mats shall be installed as indicated on the drawings, and edges overlapped a minimum of 4 inches, between all sub-grade soil and cobble. Care shall be taken to prevent tearing or excessive crushing during the installation process.

2.14 EROSION CONTROL MATERIAL

A. Erosion control material shall be jute erosion control matting available from Owner approved source. Jute erosion control matting shall be applied to landscape areas with slopes greater than 2:1. Care shall be taken to prevent tearing or excessive crushing during the installation process. Owner requests bio-degradable staking, however, if metal U-shaped stakes are used, contractor shall remove all stakes after plant material establishment.

2.15 QUALITY OF PLANT MATERIAL

A. All plant material (trees, shrubs and groundcover) shall be approved by the Owner or his designated representative prior to delivery and shipment to the job site.

B. During inspection, as set forth hereinafter, all plant material will be judged, and rejections shall be based upon these standards. All plants shall comply with federal and state law requiring inspection for plant diseases and infestations. Inspection certificates required by law shall be made available to the Owner or Owner's Representative at his/her request.

C. In determining the quality of plant material, the following elements will be valued:
1. Root condition
2. Plant size (above ground)
3. Insect and disease free condition
4. General appearance (color, shape, pruning)
A deficiency in one or more of these areas will be sufficient reason to reject selectively or by lot.

D. The Owner or his designated representative shall have the right, at any stage of the operations, to reject any and all work and materials which, in his opinion, do not meet with the requirements of these Specifications. Such rejected material shall be removed from the site and acceptable material substituted in its place.

2.16 SIZE AND MEASUREMENTS

A. Plants shall be measured when branches are in their normal position. Heights and spread dimensions specified refer to the main body of the plant and not to extreme branch tip to tip. The measurements specified are the minimum size acceptable and where pruning is required, these are measurements after pruning. When sizes are indicated as a range, the plant shall have the proper proportion as outlined in California Department of Agriculture, Grades and Standards for Nursery Plants. Caliper of trees shall be taken 12 inches above the ground level and shall be the determining measurement for trees.

B. Plants which have been headed back to conform to the size specified will not be acceptable. Plants larger than specified may be used if approved by the Owner; however, the use of such plants shall not increase the contract price.

2.17 LABEL

A. Plant materials shall have durable, legible labels stating, in weather resistant ink, the correct botanical and common names and size as indicated in the Plant List. Each plant, or sufficient representative samples of each delivered shipment, shall have labels securely attached in a fashion that will not interfere with normal plant growth. Plant materials that have (or will have) a seasonal bloom shall be tagged with labels indicating the specific variety of that species' botanical and common name.

2.18 COLLECTED PLANT MATERIAL

A. All plant material shall be nursery grown, with exception of collected specimen material. Collected specimens shall have been grown under climatic conditions similar to those in the locality of the project. All collected plants shall meet the requirements as specified and shall meet all specified grades and standards, unless otherwise qualified in the Plant List or these specifications.

2.19 CONTAINERIZED & BOXED PLANT MATERIAL

A. All boxed / container grown plants shall be well rooted and established in the container in which they are delivered to the site. The plants shall have been in that container sufficiently long for the fibrous roots to hold the soil together when the plant is removed from the container. Container grown plants found to be root-bound during planting will not be acceptable. Boxed / containerized trees have a tendency to dry out quickly. The Contractor shall be responsible for hand watering the trees at time of delivery through the time of final acceptance at a rate consistent with the nursery watering schedule to assure that the tree does not go into shock.

2.20 TAGGING OF PLANT MATERIALS

A. After receiving the Notice to Proceed, the Contractor shall locate all plants specified. The Contractor shall notify the Owner so they may agree on a time to mutually inspect the selected plants. The Owner will inspect and tag those plants that are acceptable for use. Expenses incurred by the Owner for any subsequent inspection of specimen plants, at any time, in addition to the mutually agreed time, shall be the responsibility of the Contractor.

2.21 SUBSTITUTIONS

A. The use of materials differing in kind, quality or size from those specified will be allowed only after the Owner is convinced that all means of obtaining the specified materials have been exhausted.

B. Where it is indicated that the Contractor may furnish or use a substitute that is equal to the material or equipment specified and if the Contractor is to furnish or use a proposed substitute, he shall, after the award of the contract, make written application to the Owner for acceptance of such a substitute. The substituted product or method shall be equal or superior in all respects to the specified product or method, shall perform adequately the duties imposed by the general design, shall be compatible with all other elements of the job, and shall be sufficient to complete the job. The substitution shall not add cost to the contract. Should it be necessary to accept a substitute of

a quality less than specified, the unit price shall be used to adjust the contract price downward accordingly. No substitution shall be ordered or installed without the written permission of the Owner.

PART 3 - EXECUTION

3.01 EXAMINATION / PROJECT START-UP

A. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Contractor shall examine existing site trees within the limit of work area prior to start of work. Contractor shall take videos of existing trees that show overall tree character, size and trunk structure.

C. Should trees be damaged during construction, the damaged tree shall be compared against the existing tree videos. If it is determined that the Contractor is at fault and the tree does not survive, the contractor shall replace the tree with one that matches the tree variety and size.

D. Secure permission from the Owner to store plant materials and other landscape equipment on site.

3.02 DELIVERY, STORAGE AND HANDLING OF PLANT MATERIAL

A. The Contractor shall exercise care in handling, loading and unloading, storage and transporting all plant material and allied materials to prevent damage. The Contractor shall assume full responsibility for protection and safekeeping of products stored on the job.

B. The Contractor shall dig and prepare boxed plant material for shipment in a manner that will not damage roots, branches, shape and future development after planting.

C. The Contractor shall handle all plants so that roots and branches are protected at all times from drying out, heating and from other injury. All plants shall be handled by the container.

D. Before moving plants from the nursery or storage area to the site, they shall be thoroughly sprayed with a solution of antidesiccant. Two weeks after planting, or as specified by the product manufacturer, the material shall be sprayed again with the antidesiccant. The antidesiccant shall be applied using power spray to provide an adequate film over trunks, branches, stems, twigs and foliage.

E. When transporting plants to and at the site, the Contractor shall make provisions to protect plants from wind damage by avoiding high-speed highways, transporting in enclosed or partially enclosed vehicles, or covering the plants with burlap or other suitable material. Plants severely damaged by wind will be rejected.

F. Any plant with signs of insects, their eggs or larvae, or disease will be rejected and shall be removed from the project site.

G. Only the nursery stock intended for planting on a particular day shall be delivered and stored on the site during the day unless otherwise acceptable to the Owner. All plants shall be stored in one location as designated by the Owner, protected from wind and kept moist. The roots of all plants that cannot be planted immediately in soil shall be covered with mulch and other suitable material. No plants shall be taken from the temporary storage area for planting on the project until after the tree pits or holes for the plants in the section to be planted have been properly excavated and prepared ready to receive the trees and shrubs.

H. Tree moved by winch or crane shall be thoroughly protected from chain marks, girdling, or other bark slippage by means of burlap, wood battens or other acceptable method.

3.03 NONPLANT MATERIALS

A. Fertilizer shall be delivered to the site in original, unopened containers bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law. In lieu of containers and provided that it is to be applied at the time of delivery, fertilizer may be furnished in bulk, and a certificate indicating the above information shall accompany each delivery.

B. Pesticide and herbicide materials shall be delivered to the site in the original, unopened containers. Containers that do not have a legible label that identifies the Environmental Protection Agency registration number and the manufacturer's registered uses will be rejected.

C. Storage of materials shall be in the area designated for use by the Owner. All materials shall be kept in dry storage and away from contaminants.

3.04 FINISH GRADING

A. Finish grades shall be as indicated on the Civil Engineer’s drawings.

B. Finish grades shall be measured as the final water compacted and settled surface grades and shall be within plus or minus 0.1 foot of the spot elevations and grade lines indicated on the drawing.

C. Finish grades shall be measured at the top surface of surface materials.

D. Molding and rounding of the grades shall be provided at all changes in slope.

E. All undulations and irregularities in the planting surfaces resulting from tillage, rototilling and all other operations shall be leveled and floated out before planting operations are initiated.

F. The contractor shall take every precaution to protect and avoid damage to sprinkler heads, irrigation lines and other underground utilities during the grading and conditioning operations.

G. Final finish grades shall insure positive drainage of the site with all surface drainage away from buildings, walls, and toward roadways, drains and catch basins.

H. Final grades shall be acceptable to the Landscape Architect before planting operations will be allowed to begin.

I. Planting surfaces shall be graded with no less than 1 percent surface slope for positive drainage.

J. Clean up and remove all weeds and grasses, including roots, debris and rubbish before commencing work.

K. Do not work soil when moisture content is so great that excessive compaction will occur, or when it is so dry that dust will form or clods will not readily break up.

L. Finish grade, after soil conditioning shall be one (1) inch below the tops of curbs and walks in lawn areas and two (2) inches below in shrub areas, sloping to drain to the adjacent curbs, drain swales or catch basins.

3.05 DEEP WATER LEACHING

A. Perform deep water leaching after complete installation and testing of irrigation system. All planting areas (slopes greater than 3:1 excluded) shall be deep water leached and compacted and settled by continuous application of irrigation water, until soil is moist to a minimum depth of 8 inches.

B. Care shall be taken that the rate of application of water does not cause erosion or sloughing of soils.

C. All depressions, void, erosion scars and settled trenches generated by the deep watering shall be filled with conditioned topsoil and brought to finish grade.

D. After leaching is complete, take soil samples and submit to the Testing Agency for testing. See Section 1.03.D.5.

E. If soil does not meet the above requirements, re-apply soil amendments and repeat leaching operation.

3.06 PREPARATION BEFORE PLANTING

A. Contractor shall be responsible for tilling all planting areas to a depth of 12 inches prior to applying topsoil / planting mix in order to break up compacted soils and improve interface between soil layers. Contractor is responsible for all tilling equipment to ensure area is tilled to the correct desired depth.

B. Soil Conditioning, Fertilizing and Rototilling:
   1. Once planting areas that shall not receive 12" of topsoil, have been graded and leached, the following rates of soil conditioning and amendment materials shall be evenly spread over these planting areas and shall be thoroughly scarified, to an average depth of six (6) inches by rototilling a minimum of two (2) alternating passes.
      a. Iron Sulphate: 20 lbs. per 1,000 sq. ft.
      b. Soil Conditioner: 6 cu. yds per 1,000 sq. ft.
      c. Pre Plant Fertilizer: 30 lbs. per 1,000 sq. ft.
      d. Gypsum: 100 lbs. per 1,000 sq. ft.
      e. Soil Sulfur: 10 lbs. per 1,000 sq. ft.
      f. Wetting Agent: 2 oz. per gallon

C. Rate of application is for bidding purposes only. Soil tests may reduce or increase total soil amendment yardage. See Item E below for soil testing requirements.

D. Planting Backfill – Planting backfill shall be a thoroughly blended mixture of excavated soil from the planting pits and soil amendments at the following mixture:
   1. 70% of Native Soil
   2. 30% Nitrogen Stabilized Organic Amendment
   3. 16 lbs. Gro-Power Plus
   4. 2 lbs. Ferrous Sulfate
   5. Thoroughly blend the above at a central on-site location prior to use. The ferrous sulfate should not contact paving surfaces as staining will result.

E. Soil amendments specified are for bidding purposes only. Actual types and quantities shall be based on soil analysis provided by contractor after rough grading; a soil sample shall be taken from each planting zone location for the different areas of the site to represent an adequate cross section of conditions. Testing lab shall be a firm approved by the owner and shall include tests for soil fertility, agricultural suitability, organic content, N, P, K, PH, EC; soil texture; and recommendations for amendments, leaching, and maintenance fertilization. Contractor shall furnish the project Landscape Architect and Owner's Representative with a copy of test results and receive written approval for amendments / soil preparation prior to installation.

F. The Contractor shall verify that final grades have been established prior to beginning planting operations. All unsatisfactory grading shall be reported to the Owner, and the Contractor shall not proceed with the work until the unsatisfactory conditions have been corrected. When conditions detrimental to plant growth are encountered, such as rubble, fill or adverse drainage conditions, the Contractor shall notify the Owner for directions.

G. Should undesirable existing vegetation be present on the site at the time of installation, the Contractor shall prepare the site for planting by use of chemicals, when used as recommended by the manufacturer, and/or mechanical means acceptable to the Owner.

H. Care shall be exercised to avoid any misuse of chemicals that would create detrimental residual conditions. Care must also be used not to alter final grades that have been established or cause damage to previously established turf areas.

I. All planting bed areas shall be treated with a pre-emergent herbicide (Ronstar) before planting operations.

3.07 SITE PREPARATION

A. If so called for by the Owner, all plant locations and the areas of all planting beds shall be staked out on the ground, for acceptance by the Owner, before planting operations begin. The Contractor shall stake the location of the center of each tree and paint the outline of each shrub and groundcover bed. The stakes shall be oriented in a vertical manner so that they can be viewed and read from one direction. The Contractor shall give the Owner notice 24 hours prior to the completion of staking described herein.

B. The Contractor shall verify the location of underground utilities, and irrigation heads and valves, and provide markers or other suitable protection, where necessary, to prevent damage.

3.08 EXCAVATION OF PLANTING AREAS

A. No tree or shrub pit shall be dug or prepared until their location is acceptable to the Owner. Reasonable care shall be exercised to have pits dug and soil prepared prior to moving plants to their respective locations for planting to ensure that they will not be unnecessarily exposed to drying elements or to physical damage.

B. Circular pits with non-vertical sides shall be excavated for all plants. The depth of all plant pits shall be enough to accommodate the ball or roots and the prepared soil in the bottom of the pit. Diameter of pits for trees shall be at least 1 foot greater than the diameter of the ball. Plants are to be centered in pit.

C. A Percolation Test shall be conducted in all plant beds and tree pits testing for proper drainage by filling planting holes with water twice in succession. Conditions in which the retention of more than 6 inches of water in 1 hour shall be brought to the attention of the Owner. A written proposal and cost estimate for correction of such conditions shall be submitted to the Owner for review and written acceptance, before proceeding with the work.

D. All tree pits in curbed planting islands, tree wells, or in areas in which the soil has been compacted to an undesirable density, shall be excavated to a depth at least two feet greater than the measured depth & diameter of the ball. The minimum depth & diameter of an excavation shall be four feet. Soil backfill in areas of densely compacted soil must meet specification 2.03. It is the Contractor's responsibility to dispose of the unsuitable soil to an approved location.

E. In shrub and groundcover beds where soils have been compacted to a density that is detrimental to plant growth, the Contractor shall loosen soils to a depth of 18 inch minimum to allow root penetration beyond the planting pit.

F. If acceptable for use, existing topsoil in shrub and groundcover beds shall be treated with the specified soil amendments, at rates determined by soil tests. Amendments shall be incorporated into the soil to a depth of 12 inches. Where soil is not acceptable as determined by soil tests, the soil in the entire area shall be removed to a depth of 12 inches and replaced with the specified planting soil.

3.09 PLANTING

A. All plants, except as otherwise specified, shall be centered in their pits, faced for best effect and set plumb for backfilling.

B. Plants shall be removed from cans by cutting two sides of a container with an acceptable can cutter. Sides shall not be cut with a spade. Sides of knockout cans shall not be cut. Plastic containers with slanted sides shall not require cutting. Plants shall be removed from the container carefully, without injury or damage to the plant and root system.

C. Boxed materials shall be set in final planting locations prior to installation of site paving or curbing. Contractor shall be responsible for staking of all edges of pavement prior to placement including elevation staking.

D. Bottom of boxes shall be removed before planting. Sides of the box shall be removed, without damage to the root ball, after positioning the plant and partially backfilling around it. The Contractor shall hand water containerized trees from the time of delivery until the time of final acceptance at a rate consistent with the nursery conditions from which the trees were obtained. Trees which go into shock due to insufficient water may be rejected.

E. Plants shall be set in the center of pits and shall be plumb and straight and at such a level that after settlement the root crown will be level with the surrounding grade.

F. Plant holes shall be backfilled with the specified planting mixture placed in layers around the roots or ball. Each layer shall be carefully tamped in place in a manner to avoid injury to the roots or ball or disturbing the position of the plant. When approximately two thirds of the plant hole has been backfilled, the hole shall be filled with water and the soil allowed to settle around the roots. After the water has been absorbed, the plant hole shall be filled and tamped lightly to grade. Any subsequent settlement shall be brought to grade.

G. Immediately after each tree pit is backfilled, a shallow basin slightly larger than the pit shall be formed with a ridge of topsoil to facilitate watering. This soil saucer shall be formed in a circle and tamped around each tree so that the saucer will retain water. Where curbing occurs around plant pits, the saucer shall be omitted.

3.10 FERTILIZING

A. Each tree and shrub shall be provided with plant tablets as follows:
   1. 1 tablet per 1 gallon plant
   2. 3 tablets per 5 gallon plant.
   3. 5 tablets per 15 gallon plant.
   4. 8 tablets per 24” inch box plant
   5. 12 tablets per 36” box tree and larger

3.11 TREE STAKING AND GUYING

A. Immediately after planting, trees shall be staked and guyed for support with ArborBrace Tree Guying System per manufacturer’s instructions.

B. Care shall be taken when driving anchors to avoid damaging the tree roots.

3.12 MULCHING

A. Immediately after planting operations are completed, where noted on plans planting areas shall be covered with a three (3) inch layer of Nuplay rubber mulch nuggets . Do not place mulch in immediate contact with the plant stem.

3.13 ROOT BARRIERS

A. Install root barrier where trees are planted within 60 inches of paving or other hardscape elements, such as walls, curbs, and walkways unless otherwise shown on the Drawings.

B. Align root barrier vertically and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.

C. Install root barrier continuously for a distance of ten (10) feet in each direction from the tree trunk, for a total distance of 20 feet per tree. If trees are spaced closer, use a single continuous piece of root barrier.

D. Position top of root barrier per manufacturer’s recommendations.

E. Overlap root barrier a minimum of 12 inches at joints.

F. Do not distort or bend root barrier during construction activities.

G. Do not install root barrier surrounding the root ball of tree.

3.14 HERBICIDE APPLICATION

A. Apply herbicides according to manufacturer's directions only, using all proper safety precautions. Do not apply herbicides during high winds.

3.15 POST FERTILIZATION

A. Post fertilization for all planting areas (5-3-1) shall occur 45 days after planting at a rate of 15 lbs. per 1,000 sq. ft. and again at the end of maintenance period.

3.16 PRUNING

A. Each tree and shrub shall be pruned in accordance with ANSI A300 Tree, Shrub and other Woody Plant Maintenance – Standard Practices (Pruning) and standard horticultural practice to preserve the natural character of the plant and in the manner fitting its use in the landscape design. Pruning shall be done with clean, sharp tools and as indicated on the drawings.

B. Approximately one third of the growth of large deciduous trees (those with 2 inch caliper or larger) shall be pruned by removal of superfluous branches. Main leaders of trees shall not be cut back. Branches shall be thinned out and not merely cut back. Long side branches may be shortened. Shrubbery with extremely heavy tops shall have one fourth to one third of the weaker growth removed by thinning.

3.17 CLEANUP

A. During the course of planting, excess and waste materials shall be continuously and promptly removed daily, lawns kept clear, and all reasonable precautions taken to avoid damage to existing structures, plants and grass. After completion of the work, the entire site shall be cleared of excess soils, waste material, debris and all objects that may hinder maintenance and affect the visual appearance of the site.

B. The Contractor shall clean all roads and walks of dirt film and soil clods. The Contractor shall also pressure clean and broom sweep all asphalt pavement prior to the final lift of asphalt to be laid.

3.18 DISTURBED AREAS

A. All areas outside of the limits of work that are disturbed by the Contractor's construction activities shall be repaired and replanted to its original condition.

3.19 FINAL INSPECTION AND ACCEPTANCE

A. The Contractor shall notify the Owner in writing when the work has been completed in accordance with this Contract and request an inspection. The Owner will make the inspection of the work and report findings as to acceptability and completeness. Any work remaining to be done shall be subject to re-inspection before final acceptance. The Contractor will be notified in writing by the Owner of the final acceptance of the work.

3.20 CONTRACTOR'S RESPONSIBILITY AFTER ACCEPTANCE

A. The Owner may elect to assume maintenance of all work, at the time of acceptance, or may elect to contract for maintenance by others for a specified period. Should maintenance after final acceptance is the responsibility of those other than the Contractor, the Contractor shall monitor all work for which he is responsible by guarantee; to assure that maintenance being performed will not jeopardize the condition and quality of the work and materials guaranteed by the Contractor. Any inadequate or damaging maintenance practices shall be reported immediately in writing to the Owner so that appropriate measures may be taken to correct the condition. Failure to so notify the Owner will invalidate any later claim of negligence or malpractice in maintenance.

3.21 ACCEPTANCE AND REPLACEMENT OF PLANT MATERIAL

A. At the expiration of the proving period, an inspection of the plantings will be made by the Owner. Only those plants that are alive and normally healthy will be accepted. Unaccepted material shall

be removed and replaced by the Contractor at his own expense, during the next planting season. Material and method of replacement planting shall be the same as specified for the original planting unless otherwise directed. The Contractor shall continue to make replacements until a plant shows vigorous and healthy growth for a period of 1 year from the date of acceptance by the Owner. All such replacements will be inspected for acceptance at the end of the proving period by the Owner.

END OF SECTION

SECTION 330516

UTILITY STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes materials, construction, installation and testing for the construction of storm drain structures, including cast-in-place Standard Drawing concrete storm drain inlets, outlets, prefabricated inlets, clean-outs. This scope of work includes but is not limited to, material for structures, trenching, structure installation, placement, backfilling, and compacting of backfill material.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 013300 – Submittal Procedures

B. Section 312200 - Grading

C. Section 312333 – Trenching, Excavation, Backfilling and Compacting

D. Section 334000 – Storm Drainage Utilities

1.03 REFERENCE STANDARDS

A. Standard Specifications
   1. Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including the Regional Supplement.

B. Standard Drawings
   1. City of San Diego Standard Drawings for Public Works Construction, 2018 Edition
   2. San Diego Regional Standard Drawings (2012).

C. American Society for Testing and Materials (ASTM)

1.04 SUBMITTALS

A. General: Refer to Section 013300 - Submittal Procedures, for submittal requirements and procedures.

B. ADA Compliance: Inlet grates in paving shall be submitted with manufacturer's certification that it is ADA compliant.

PART 2 - MATERIALS

2.01 CAST-IN-PLACE CONCRETE STORM DRAIN STRUCTURES

A. Materials: Comply with requirements of Section 201-1 – Portland Cement Concrete of the SSPWC, and SDRSD.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Requirements: Construct cleanouts, catch basins, inlets, and outlets, utility boxes and vaults, and related utility structures in connection with the installation of pipe, conduits, duct banks, and utility trenches, as indicated in the Construction Plans and Standard Specifications, City of San Diego Standard Drawings, and San Diego Regional Standard Drawings (SDRSD).

B. Excavation and Backfill: Provide excavation, prepared subgrade and aggregate base, and backfill as specified in Section 312333 – Trenching, Excavation, Backfilling and Compacting.

PART 4 - MEASUREMENT AND PAYMENT

4.01 UTILITY STRUCTURES

A. Full compensation for work that is specified, shown on the drawings, or required per the Contract without a specific Bid item listed for such work shall be included in the prices paid for various corresponding Contract items of work in the Bid Schedule and no additional compensation will be allowed therefore.

B. Full compensation for conforming to the requirements of this Section, UTILITY STRUCTURES, including all labor, materials, equipment, tools, and incidentals will be considered included in the Unit Price paid for the various items listed in the Bid Schedule and no additional compensation will be allowed therefore.

END OF SECTION

SECTION 331000

WATER PIPING SYSTEM AND APPURTENANCES

PART 1 - GENERAL

1.01 SUMMARY

A. This section describes the requirements and procedures for installation of water piping systems and appurtenances. This scope of work includes but is not limited to, pipe material, fittings, thrust blocks, and appurtenances, pipe installation, trenching, placement, backfilling and compacting of pipe zone and trench zone material; handling, stockpiling, managing, draining, and drying of the saturated soil; and preparation of the containment system for the temporary stockpile for saturated soil, pressure testing and disinfection, connection to existing waterlines and pressure testing and disinfection of water lines.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 013300 – SUBMITTAL PROCEDURES

B. Section 312333 – Trenching, Excavation, Backfilling, and Compacting

1.03 REFERENCE STANDARDS

A. Standard Specifications
   1. Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including Regional Supplement.

B. Standard Drawings
   1. City of San Diego Standard Drawings for Public Works Construction, 2018 Edition
   2. San Diego Regional Standard Drawings (2012).

1.04 SUBMITTALS

A. General: Refer to Section 013300 – SUBMITTAL PROCEDURES, for submittal requirements and procedures.

B. Product Data: Submit manufacturers' product data for pipe and pipe connection materials, and appurtenances.

1.05 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Section 017839 - Project Record Documents.

B. Accurately record location of pipe runs, connections, manholes, cleanouts, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 - PRODUCTS

2.01 WATER PIPELINE AND APPURTENANCES

A. Water pipeline, materials and appurtenances shall be as indicated on the contract drawings and shall conform to the City of San Diego Standard Specifications, approved materials list, and Standard Drawings for Construction of Water Facilities.

B. Thrust blocks shall be per City of San Diego Standard Specifications.

PART 3 - EXECUTION

3.01 WATER PIPELINE INSTALLATION

A. Water pipeline installation shall be completed per the contract drawings and shall conform to the City of San Diego Standard Specifications for Construction of Water Facilities.

B. The Contractor shall provide an acceptable source of water, and all labor equipment and materials necessary for pressure testing and disinfection. Test gauge shall display latest test calibration, the Engineer may require additional gauge installation to monitor test.

END OF SECTION

SECTION 331300

DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

B. Section 331000 - Water Piping System and Appurtenances.

1.02 SECTION INCLUDES

A. Disinfection of potable water distribution and transmission system.

B. Testing and reporting results.

1.03 SUBMITTALS FOR INFORMATION

A. General: Refer to Section 013300 - Submittal Procedures, for submittal requirements and procedures.

B. Test Reports: Indicate results comparative to specified requirements.

C. Certificate: Certify that cleanliness of water distribution system meets or exceeds specified requirements.

1.04 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 017839 - Project Record Documents.

B. Disinfection report:
   1. Type and form of disinfectant used.
   2. Date and time of disinfectant injection start and time of completion.
   3. Test locations.
   4. Initial and 24-hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
   5. Date and time of flushing start and completion.
   6. Disinfectant residual after flushing in ppm for each outlet tested.

C. Bacteriological report:
   1. Date issued, project name, and testing laboratory name, address, and telephone number.
   2. Time and date of water sample collection.
   3. Name of person collecting samples.
   4. Test locations.
   5. Initial and 24-hour disinfectant residuals (quantity in treated water) in ppm for each outlet
   6. tested.
   7. Coliform bacteria test results for each outlet tested.
   8. Certification that water conforms, or fails to conform, to bacterial standards of Federal,
   9. State, and local water quality codes.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C651.

B. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.

C. Testing Firm: Company specializing in examining potable water systems, certified by the State in which the project is located.

D. Submit bacteriologist's signature and authority associated with testing.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code or regulation for performing the work of this Section.

B. Provide certificate of compliance from authority having jurisdiction indicating approval of water system.

PART 2 - PRODUCTS

2.01 DISINFECTION CHEMICALS

A. Chemicals: AWWA B300, Hypochlorite, or AWWA B301, Liquid Chlorine, or substitute approved by authority having jurisdiction.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that piping system has been cleaned, inspected, and pressure tested.

B. Perform scheduling and disinfecting activity with start-up, testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.02 EXECUTION

A. Meet all requirements of authority having jurisdiction.

B. Provide and attach required equipment to perform the work of this Section.

C. Introduce treatment into piping system.

D. Maintain disinfectant in system for 24-hours or as required by authority having jurisdiction.

E. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.

F. Replace permanent system devices removed for disinfection.

G. Pressure test system. Repair leaks and re-test.

3.03 FIELD QUALITY CONTROL

A. Test samples in accordance with AWWA C651.

END OF SECTION

SECTION 333000

SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

1.02 SECTION INCLUDES

A. Sanitary drainage piping, fittings, and accessories.

B. Connection of building sanitary drainage system to municipal sewers.

C. Cleanout access.

1.03 REGULATORY REQUIREMENTS

A. Conform to applicable codes and requirements of authority having jurisdiction for materials and installation of the Work of this Section.

1.04 SUBMITTALS

A. No submittals required for this Section.

1.05 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Section 017839 - Project Record Documents.

B. Accurately record location of pipe runs, connections, manholes, cleanouts, and invert elevations.

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 - PRODUCTS

2.01 SEWER PIPE MATERIALS

A. Per plans.

2.02 PIPE ACCESSORIES

A. Fittings: Same material as pipe, molded or formed to suit pipe size and end design, in required "T", bends, elbows, cleanouts, reducers, traps, and other configurations required.

2.03 CLEANOUTS

A. Per UPC.

2.04 FILL MATERIAL

A. Per Section 312333 – Trenching and Backfilling.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that trench cut is ready to receive work, and excavations, dimension, and elevations are as indicated on Drawings.

B. Beginning of installation means acceptance of existing conditions.

3.02 PREPARATION

A. Hand trim excavations to required elevations.

B. Remove large stones or other hard matter which could damage drainage tile or impede consistent backfilling or compaction.

3.03 INSTALLATION – PIPE

A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal joints watertight.

B. Prepare and compact pipe zone per 312333 – Trenching and Backfilling.

C. Lay pipe to slope gradients noted on drawings, with maximum variation from true slope of 1/8” in 10-feet.

D. Install backfill at sides and minimum of 6-inches over top of pipe.

E. Refer to Section 312333 – Trenching and Backfilling, for fill placement and compaction requirements. Do not displace or damage pipe when compacting.

3.04 INSTALLATION – CLEANOUTS

A. Form bottom of excavation clean and smooth to correct elevation.

B. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.05 FIELD QUALITY CONTROL

A. Field inspection will be performed under provision of Section 014529 - Testing Laboratory Services.

3.06 PROTECTION

A. Provide temporary and removable protection for installed products. Control activity in immediate work area to minimize damage.

3.07 LEAKAGE TESTING

A. Test all non-sewer pipe installations in accordance with Uniform Plumbing Code and local jurisdictional requirements.

END OF SECTION

SECTION 333913

SANITARY UTILITY SEWERAGE MANHOLE FRAMES AND COVERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provisions established within the General and Supplementary General Conditions of the Contract, Division 1 - General Requirements, and the Drawings are collectively applicable to this Section.

B. Section 334900 - Storm Drainage Systems.

C. Section 333000 - Sanitary Sewer Systems.

1.02 SECTION INCLUDES

A. Modular precast concrete manhole sections with tongue-and-groove joints, covers, anchorages, and accessories.

1.03 REFERENCES

A. Standard Specifications
   1. Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including the Regional Supplement.

B. Standard Drawings
   1. City of San Diego Standard Drawings for Public Works Construction, 2018 Edition
   2. San Diego Regional Standard Drawings (2012).

C. American Society for Testing and Materials (ASTM):

D. ASTM A.4 - Gray Iron Castings.

E. ASTM C478 - Precast Reinforced Concrete Manhole Sections.

F. ASTM C923 - Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes.

1.04 SUBMITTALS

A. General: Refer to Section 013300 - Submittal Procedures, for submittal requirements and procedures.

B. Product Data: Provide manhole covers, component construction, features, configuration and dimensions.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Maintain materials and surrounding air temperature to minimum 50 degrees F (10 degrees C) prior to, during, and 48-hours after completion.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478 with gaskets in accordance with ASTM C443. Minimum wall thickness 4-inches. Provide concentric cones or flat top manhole sections where necessary.

B. Mortar: Standard pre-mix mortar conforming to ASTM C387, Type N.

2.02 COMPONENTS

A. Lid and Frame: ASTM A48, Class 30B cast-iron construction, machined flat bearing surfaced, removable lid of the size and shape detailed on the drawings.

B. Manhole Steps: Formed galvanized steel 3/4-inch diameter. Formed integral with manhole sections.

C. Base Pad: Cast-in-place concrete leveled top surface.

2.03 CONFIGURATION

A. Shaft Construction: Concentric with eccentric cone top section; lipped male/female joints; sleeved to receive pipe sections.

B. Shape: Cylindrical.

C. Clear Inside Dimensions: As indicated.

D. Design Depth: As indicated.

E. Clear Lid Opening: As indicated.

F. Pipe Entry: Provide openings as required.

G. Steps: 12-inches wide, 16-inches on center vertically, set into manhole wall.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify items provided by other sections of Work are properly sized and located.

B. Verify that built-in items are in proper location, and ready for roughing into Work.

C. Verify excavation for manholes is correct.

3.02 PREPARATION

A. Coordinate placement of inlet and outlet pipe required by other sections.

3.03 PLACING MANHOLE SECTIONS

A. Prepare excavations per Section 312333 – Trenching and Backfilling, and place 3/4 inch aggregate base per typical sections prior to setting base pad.

B. Place base pad, trowel top surface level.

C. Place manhole sections plumb and level, trim to correct elevations, anchor to base pad.

D. Cut and fit for pipe.

E. Grout base of shaft sections to achieve slope to exit piping and assure accurate invert elevations. Trowel smooth. Channel as required.

F. Set cover frames and covers level without tipping, to correct elevations.

G. Coordinate with other sections of work to provide correct size, shape and location.

H. Flexible Joints:
   1. Provide joints in non-reinforced concrete sewers not more than 18-inches from manhole walls. Lay pipes entering manholes on firmly compacted base rock to undisturbed earth. Base rock shall be as specified.
   2. Where the last joint of the line laid up to the manhole is more than 18-inches from the manhole base, a 6-inch concrete encasement shall be constructed around the entire pipe from the manhole base to within 18 -inches of the pipe joint. The pipe encasement shall be

constructed monolithically with the manhole base. Pipes laid out of the manhole shall be shortened to ensure that the first joint is not more than 18 -inches from the manhole base.

I. Install extensions in conformance with the details shown on the drawing, and to height required to match final grade. Lay grade rings in mortar with sides plumb and tops level. Seal joints with mortar as specified for manhole sections. Extensions shall be watertight.

END OF SECTION

SECTION 334000

STORM DRAIN UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. This scope of work in this section is for the materials and installation of 6-inch to 36-inch perforated, and solid PVC storm drain pipe utilities, and includes but is not limited to, pipe material, trenching, pipe installation,; placement, backfilling, and compacting of pipe zone and trench zone material; handling, stockpiling, managing, and connection to existing, and proposed storm drain structures and facilities

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 013300 – Submittal Procedures

B. Section 312333 – Trenching, Excavation, Backfilling and Compacting

C. Section 330516 – Utility Structures

1.03 REFERENCE STANDARDS

A. Standard Specifications
   1. Standard Specifications for Public Works Construction (SSPWC), 2018 Edition (Green Book), including the Regional Supplement.

B. Standard Drawings
   1. City of San Diego Standard Drawings for Public Works Construction, 2018 Edition
   2. San Diego Regional Standard Drawings (2012).

C. American Society for Testing and Materials (ASTM):

1.04 SUBMITTALS

A. General: Refer to Section 013300 - Submittal Procedures, for submittal requirements and procedures.

B. Prior to construction Contractor to submit for review and approval a Stormwater Diversion Plan. See Section 024100 DEMOLITION for submittal requirements.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with AWWA C651.

B. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.

C. Testing Firm: Company specializing in examining potable water systems, certified by the State in which the project is located.

D. Submit bacteriologist's signature and authority associated with testing.

PART 2 - MATERIALS

2.01 PIPE SPECIFICATIONS

A. PVC Pipe Specifications shall be per the Construction plans and SSPWC.

B. Bedding and Backfill Material: Refer to Section 312333 – Trenching, Excavation, Backfilling and Compacting for requirements.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE

A. Pipe installation shall conform to Section 306-1.2 of the SSPWC.

B. Excavation and Bedding:
   1. Excavations:
      a. Excavate trenches as specified in Section 312333 – Trenching, Excavation, Backfilling and Compacting.
   2. Bedding: Provide bedding as specified in Section 312333 - Trenching, Excavation,
   3. Backfilling and Compacting for Utilities, as shown on the drawings, and SDRSD.
   4. Backfilling:
      a. Piping shall not be covered with backfill material, until inspected, tested, and approved by the District.
      b. After pipe has been installed, inspected, and approved, place and compact backfill as specified in Section 312333 – Trenching, Excavation, Backfilling and Compacting.
      c. Contractor shall complete concrete slurry backfilling promptly and efficiently in order to minimize the dewatering operations.

3.02 CONSTRUCTION ADJACENT TO AND/OR ACROSS EXISTING UTILITIES

A. Construction adjacent to and/or across existing utilities shall be in accordance with Section 312333 – Trenching, Excavation, Backfilling and Compacting, Part 3.05. The cost for construction adjacent to and/or across existing utilities shall be included in the various corresponding Contract items of work in the Bid Schedule and no additional compensation will be allowed therefore.

PART 4 - MEASUREMENT AND PAYMENT

4.01 UTILITY STRUCTURES

A. Full compensation for conforming to the requirements of this Section, UTILITY STRUCTURES, including all labor, materials, equipment, tools, and incidentals will be considered included in the Unit Price paid for the various items listed in the Bid Schedule and no additional compensation will be allowed therefore.

END OF SECTION

SECTION 412223

HOISTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes
   1. Chain hoist.
   2. Motorized trolley.
   3. Push-button control station.

1.02 RELATED SECTIONS

A. Section 033000 Cast-In-Place Concrete

B. Section 051200 Structural Steel Framing: Hoist Beam

C. Section 055000 Metal Fabrications

D. Division 26 – Electrical: Power and Controls

1.03 REFERENCE STANDARDS

A. ASME B30.11 Monorails and Underhung Cranes

B. ASME B30.16 Overhead Hoists (Underhung)

C. HMI-100 Hoist Manufacturers Institute (HMI)

D. Monorail Manufacturers Association

E. NFPA 70 - National Electric Code

1.04 SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
   2. Include rated capacities, operating characteristics**,** electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings
   1. Include plans, elevations, sections, and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Include diagrams for power, signal, and control wiring.
   4. Description of control system.
   5. Installation instructions including shop and field testing procedures.
   6. Recommended spare parts other than those specified.

C. Delegated-Design Submittal: Include structural analysis data for fabrications to comply with design loads; signed and sealed by the qualified professional engineer responsible for their preparation and licensed by the authority having jurisdiction.

D. Contract Closeout Submittals
   1. Operation and maintenance data.
   2. Warranty.

1.05 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.

1.06 QUALITY ASSURANCE

A. Manufacturer
   1. Minimum of five years of experience in the design and manufacture of systems of the specified size and type.
   2. Member of Hoist Manufacturers Institute (HMI) and the Monorail Manufacturers Association.
   3. Equipment furnished under this specification shall conform to the recommendations of the HMI.
   4. Equipment provided under this specification shall be obtained from a single supplier or manufacturer who shall assume responsibility for the complete system.

B. Installer: Manufacturer or a qualified installer approved by the manufacturer.

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.

PART 2 - PRODUCTS

2.01 CRANE SYSTEMS

A. Basis-of-Design: ACCO Material Handling Solutions, 800-652-1932, www.accoMHS.com; Model “ACCOLIFT”, 2130160-VFD-1

B. Acceptable models include:
   1. Harrington Hoist & Cranes, phone: 800-233-3010; www harringtonhoists.com; Model NER2M050L with SC2076
   2. R. Stahl, Inc., 843-767-1951, www.stahlcranes.com; Model ST 3016-8/2

C. Substitutions: See Section 016000 - Product Requirements

D. Criteria
   1. Capacity: 6,000 lbs., minimum.
   2. Span: As shown on Drawings.
   3. Clearances: To be coordinated with Ride Package.

2.02 CHAIN HOIST

A. Hoist drive shall include a direct-coupled motor, solenoid brake, geared train with inherent load brake, motor brake, built-in load limiter, hook, chain, bottom block, load sheave, adjustable limit stop and drum.

B. Chain Drive
   1. Load bearing components directly integrated into high-tensile grey cast iron.
   2. Wear-resistant case-hardened chain sprocket with return sheaves.
   3. Enclosed self-lubricating chain guide.

C. Motor
   1. High-duty cycle and multiple switching operations.
   2. Standard fan cooling. Thermistor temperature control.
   3. Lift: As required to meet clearances.
   4. Lifting Speed Capacity: 15/5 fpm, single speed.
   5. Trolley Speed Capacity: 50/17 fpm, dual speed.
   6. Duty Class: H-3, HMI-100.
   7. Voltage: 230-460V, 60 Hz.

D. Finish
   1. Primer: One coat epoxy paint.
   2. Top Coat: Polyurethane paint. Color: RAL 7021 Greyish black.

E. Trolley
   1. Fabricated of structural steel plates, channels, and angles precision machined to accept the hoist and traverse mechanism without shimming or selective fitting.
   2. Provide restraining lugs on trolley to limit drop of the trolley to one inch or less, and to prevent rotational movement in all three axes.
   3. Compatible with hoist assembly.
   4. Trolley Wheels: Hardened treads, precision ball bearings, compatible with furnished beams, and removable without removing the trolley from the track. Quantity: Four.

F. Controls
   1. Contactor control including main contactor.
   2. Plug connection of control pendant and travel motor.
   3. Control Pendant
      a. Control cable.
      b. Emergency stop palm button.
      c. Switching selections to be two-steps.
      d. Load display.
   4. Operational hoist limit switch. Cut-off in top and bottom position.

G. Brakes
   1. Low-maintenance, asbestos-free electromagnetic disc brake.
   2. Oversized braking torque.
   3. Enclosed, protected from humidity, vapors, and dust.
   4. Provide optional bypass brake.

H. Overhead Slipping Clutch and Gear: Adjustable from exterior of housing.

I. Chain
   1. Surface-hardened, galvanized, large dimension load chain.
   2. Chain Guide: Grey cast iron.
   3. Hook block: Two-fall type.

J. Chain Box: Sheet steel, paint.

2.03 ACCESSORIES

A. Hardware for mounting of motor drives and control panels shall be Type 316 stainless steel.

2.04 SPARE PARTS

A. One replacement parts kit and one operating coil for each main contactor installed.

B. One complete set of linings for each type and size of brake.

C. One replacement set of all collector shoes.

D. One replacement chain with hook block.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Alignment: Coordinate hoist travel and positioning for accurate alignment and required clearances between components including hoist, doors, and door frame at each position.

B. Adjust hoist for accurate stopping and leveling at each position, within required tolerances.

C. Lubricate operating parts of hoist, including chain with manufacturer’s supplied lubricant. Chain box must move freely.

3.03 FIELD QUALITY CONTROL

A. Acceptance Testing: On completion of installation and before permitting use of hoist, perform acceptance inspections and tests as required by manufacturer.

B. Operating Test: Load hoist to rated load and operate continuously for 30 minutes between lowest and highest landings served. Readjust devices for accurate stopping and operation of system.

C. Advise Owner’s Project Manager in advance of dates and times tests are to be performed.

3.04 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hoist.

END OF SECTION