

PROJECT MANUAL

AMERICAN FURNITURE WAREHOUSE

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Colorado Springs, Colorado

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BDG Project No.: 20068.100

October 15, 2024

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SOILS INVESTIGATION DATA

1.0 SOILS REPORT

1.1 INVESTIGATION

- A. A soil and subsurface investigation was conducted at the site, the results of which is to be found in the Project Soils Report No. 20-2-234A, prepared by Kumar & Associates, dated August 22, 2024. A copy of the report is attached.

1.2 INTERPRETATION

- A. Soil investigation data is provided as part of the Contract Documents and shall be relied upon to the extent of the information given in the report. Contractor is urged to examine the report and the site and determine the character of materials and conditions to be encountered in the performance of the Work. Owner and Architect disclaim any responsibility for interpretation of data within the report by the Contractor.

END OF DOCUMENT



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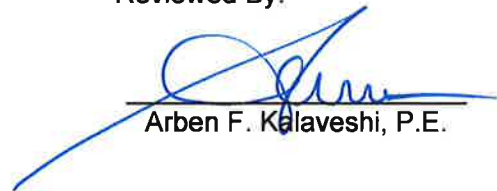
Office Locations: Denver (HQ), Parker, Colorado Springs, Fort Collins, Glenwood Springs, and Summit County, Colorado

GEOTECHNICAL ENGINEERING STUDY
PROPOSED AMERICAN FURNITURE WAREHOUSE
AMERICAN HEIGHTS &
TUTT BOULEVARD
COLORADO SPRINGS, COLORADO

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Project No. 20-2-234.A

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SUMMARY

1. Information on the subsurface conditions was obtained by reviewing our previous reports and drilling 17 supplemental borings at the approximate locations shown on Fig. 1. Borings 1 thru 5 were drilled in 2020, and Borings 6 thru 17 were drilled in 2024 as part of this current report update.

A thin layer of topsoil was encountered at the surface in a majority of the borings. In 13 of the 17 borings, man-placed fill consisting of silty to clayey sand (SM, SC, SC-SM), and well-graded sand with silt (SW-SM) was encountered, and extended to depths ranging from approximately 1 to 8 feet. This study did not determine the exact lateral or vertical extent of the fill. The underlying native subsoils encountered were consistent with the previous study, and included silty sand, with less frequently occurring lean clay and clayey sand. The native soils extended to depths ranging from approximately 4 feet to 25 feet in 15 of the borings, and to the 10 to 25-foot depths explored in Boring 4 and 9, respectively. Except for Borings 4 and 9, the overburden soils are underlain by claystone or sandstone bedrock which extends to the maximum 20 to 30-foot depths explored.

2. A summary of the groundwater levels measured is presented in the table below. Fluctuations in the water level may occur with time.

Boring	Day of Drilling	7 to 9 Days After Drilling	Boring	Day of Drilling	7 to 9 Days After Drilling
1	-	18.5'	10	17'	16.6'
2	16'	19'	11	20'	-
3	21'	20.7'	12	-	13.9'
4	-	-	13	14.5'	14'
5	-	-	14	-	-
6	12'	11.3'	15	-	18.2'
7	9'	9.7'	16	-	13.7'
8	12'	12'	17	-	13.8'
9	17'	15.7'			

3. In order to provide more uniform support, we recommend the building and retaining wall foundations bear on a minimum 3-foot-thick layer of nonexpansive structural fill. Any areas of existing fill or loose or soft material encountered within the base of the initial 3-foot overexcavation should be removed and replaced with structural fill. Additionally, at a minimum, we recommend the native clay soils and claystone bedrock, where present within 8 feet below the proposed foundation bearing elevation, be overexcavated and replaced with nonexpansive structural fill. We should be consulted at the time of excavation to assist the contractor in determining the additional limits of overexcavation required to remove the deeper fills and shallow expansive materials that remain after the initial 3-foot overexcavation is cut. Footings placed on the structural fill should be designed for an allowable soil bearing pressure of 2,500 psf.
4. Floor slabs should be supported on the on-site native granular soils and/or on a layer of nonexpansive structural fill. Clay soils and claystone bedrock present within 6 feet of the proposed floor slab elevation should be overexcavated and replaced with nonexpansive structural fill.

5. Based on the subgrade conditions encountered and the traffic information previously provided, we recommend the pavement sections presented in the table below. Clay and claystone materials encountered within 2 feet of pavement subgrade elevation should be overexcavated and replaced suitable nonexpansive fill. Additional pavement design and construction criteria are presented in the body of this report.

Location	Minimum Pavement Section Thickness (inches)		
	Portland Cement Concrete	Full-Depth Asphalt	Composite Asphalt over Base Course
Parking Lot, Autos Only	6	5.5	4 over 6
Fire Lane	6.5	6	4.5 over 6
Access Drive Lanes & Areas w/Truck Traffic	7	8	6 over 8

PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical engineering study for the proposed American Furniture Warehouse to be located between Tutt Boulevard and Powers Boulevard, south of the Templeton Gap Landfill in Colorado Springs, Colorado. Kumar and Associates previously prepared a geotechnical engineering report for the proposed development, Project No. 062-259.C, dated March 29, 2007, along with an updated report, Project No. 20-2-234, dated December 3, 2020. The purpose of this study was to confirm that the recommendations previously provided remain applicable for the proposed construction, and to provide supplemental recommendations for the proposed retaining walls which were not previously studied. The project site is shown on Fig. 1. The study was conducted in general accordance with the scope of work in our proposal C24-248, dated July 10, 2024.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to the proposed construction are included in the report.

PROPOSED CONSTRUCTION

We understand the proposed construction will be very similar to what was studied in 2007 and 2020. The building will have approximate plan dimensions of 940 X 375 feet, and will be in the approximate location that was studied previously. The building will consist of precast-concrete and

steel-frame construction with a slab-on-grade floor. It is our understanding that it is preferred to support the building with a spread-footing foundation system. From our previous study, we have assumed maximum anticipated foundation loads of 450 kips for columns and 15 kips per linear foot for walls in the mezzanine area, and maximum foundation loads of 150 kips for columns and 10 kips per linear foot for walls in the warehouse area. An asphalt parking lot and a concrete loading dock area are proposed south of the building; two access roads (American Heights) will be constructed to connect the parking and loading areas to Tutt Boulevard; and a fire lane road will be constructed around the building. A fueling station will be constructed southeast of the warehouse loading pavement area, and is anticipated to consist of a small single-story wood-framed structure with buried fuel tanks.

As part of the project, we understand cantilevered cast-in-place concrete or CMU retaining walls and screen walls will be constructed throughout the site. Our understanding of the proposed walls are summarized below.

Wall	Location	Approx. Length (ft)	Approx. Max. Height (ft)
A	SW corner of lot	610	12
B	W side of lot	900	15
C	NE corner of lot	720	16
D/E	Screen Wall, S of Bldg.	900	8

Based on the topography provided, we have assumed site grading will be similar to what was proposed previously, with cuts and fills on the order of up to approximately 15 feet within the building footprint, with cuts within the eastern approximately 1/3 of the building, and fills for the remainder of the footprint.

If loadings, locations or conditions are significantly different from those described above or depicted in this report, we should be notified to reevaluate the recommendations contained herein.

SITE CONDITIONS

At the time of our field investigation, the site generally consisted of vacant land. The area of proposed development is bounded to the north by the closed Templeton Gap Landfill, to the south by a residential development, to the east by vacant land, and to the west by Powers Boulevard. Tutt Boulevard is located nearby to the east. Tutt Boulevard included two road cuts for future expansion, presumably for the proposed American Heights, one on the west side of a roundabout, and the second roughly 500 feet south of the roundabout. Topography on the subject site generally slopes gently to moderately to the west and southwest. Along the approximate eastern edge of the proposed building and loading dock pavement area, the ground surface was benched and

approximately 3 to 4 feet higher to the east. There was roughly 25 to 30 feet of relief within the proposed building footprint. A drainage ditch that varies from 2 to 4 feet deep runs east to west, and crosses thru a buried culvert structure before terminating into a detention pond on the west side of the property. The pond contained water at the time of our study. An access loop is located on the east half of the site, which is currently aggregate surfaced, although may have been partially asphalt paved in the past, based on the asphalt fragments around the southeast portion of the loop. Portions of this access loop have become incised by erosion, with depths of erosion greater than a foot in areas. Vegetation on the majority of the site consists of grasses, weeds, yucca and cactus. It appears some site grading has occurred since our 2007 study, as the detention pond and culvert structure were new to the site at the time of our study in 2020, as well as the access loop. Additionally, the site grades appear to be altered, with some unknown amount of cut and fill occurring, and the two natural drainages identified in our 2007 study no longer present.

SUBSURFACE CONDITIONS

Information on the subsurface conditions was obtained by reviewing previous reports and drilling 17 supplemental borings at the approximate locations shown on Fig. 1. Borings 1 thru 5 were drilled in 2020, and Borings 6 thru 17 were drilled in 2024 as part of this current report update. The boring logs and corresponding legend and notes are presented on Figs. 2 thru 6. Results of the laboratory testing program from borings drilled for this study are shown on Figs. 2 through 17 and are summarized on Table I. The laboratory testing was conducted in general accordance with applicable ASTM standards. The following subsurface descriptions are of a generalized nature to highlight the major stratification features encountered in the borings drilled for this study. The boring logs should be referenced for more detailed information. Additionally, the 2007 geotechnical engineering report with associated boring logs and laboratory test results are included in the appendix for reference.

A thin layer of topsoil was encountered in a majority of the borings. In 13 of the 17 borings, man-placed fill consisting of silty to clayey sand (SM, SC, SC-SM), and well-graded sand with silt (SW-SM) was encountered, and extended to depths ranging from approximately 1 to 8 feet. This study did not determine the exact lateral or vertical extent of the fill. The composition of the fill is similar to what was encountered in 2007; however, the more frequent occurrence of the fill is a notable difference. As part of the 2007 study, only one boring encountered fill, and it was located at the western side of the site, in the area of the current detention pond.

The underlying native subsoils encountered were consistent with the previous study, and included silty sand, with less frequently occurring lean clay and clayey sand. The native soils extended to

depths ranging from approximately 4 feet to 25 feet in 15 of the borings, and to the 10 to 25-foot depths explored in Boring 4 and 9, respectively. Sampler penetration blow counts indicate the granular soils are very loose to dense, and the lean clays are medium stiff to hard. Results of swell-consolidation tests presented on Figs. 7 thru 11 indicate the tested samples of silty sand and silty-clayey sand were nonexpansive, the tested sample of clayey sand had a low swell potential, and the tested samples of lean clay had a low to moderate swell potential when samples were wetted under a constant 1-ksf load. From 2007, testing indicated the clay varied from moderately compressible to having a moderate to high swell potential.

With the exception of Borings 4 and 9, the overburden soils are underlain by claystone or sandstone bedrock which extends to the maximum 20 to 30-foot depths explored. Sampler penetration blow counts indicate the bedrock is medium hard to very hard. Results of swell-consolidation tests presented on Figs. 7 thru 11 indicate the tested samples of claystone had a low to moderate swell potential when wetted under a constant 1-ksf load. The tested samples of claystone in our 2007 report ranged from a low to high swell potential.

A summary of the groundwater levels measured is presented in the table below. As noted previously, Borings 1 thru 5 were drilled in November of 2020, and Borings 6 thru 17 were drilled in August of 2024. Fluctuations in the water level may occur with time.

Boring	Day of Drilling	7 to 9 Days After Drilling	Boring	Day of Drilling	7 to 9 Days After Drilling
1	-	18.5'	10	17'	16.6'
2	16'	19'	11	20'	-
3	21'	20.7'	12	-	13.9'
4	-	-	13	14.5'	14'
5	-	-	14	-	-
6	12'	11.3'	15	-	18.2'
7	9'	9.7'	16	-	13.7'
8	12'	12'	17	-	13.8'
9	17'	15.7'			

GEOTECHNICAL CONSIDERATIONS

Existing fill was encountered in 15 of the 17 borings, and it appears that previous site grading has occurred on the property, after it was studied in 2007. Sampler penetration blow counts and measured in-situ moisture contents suggest portions of the fill had been compacted, however, given

the unknown history of the fill, it is our opinion that it should be considered unsuitable for support of the proposed foundations and floor slabs unless documentation is available stating the site fills were properly controlled to the compaction criteria presented in this report. Foundations and floor slabs placed on uncontrolled fill can experience large total and differential movement resulting structural distress, particularly if debris or loose zones are present within the existing fill zone. We recommend the existing fill, where present below proposed foundations and floor slabs be overexcavated, moisture conditioned, and placed back properly compacted.

As an additional consideration, and what was identified from the 2007 study and confirmed with our supplemental borings, native clay soils and claystone bedrock with a low to high swell potential were encountered near the assumed foundation bearing elevation in the exploratory borings drilled in the eastern portions of the building footprint. Shallow foundations placed directly on or near expansive materials similar to that encountered at this site can experience movement causing structural distress if the materials are subjected to changes in moisture content. Straight-shaft piers drilled into the bedrock are usually the preferred foundation system for this condition; however, we understand from the previous study that spread footings were preferred. If this is no longer the case and a drilled pier foundation will be considered, we should be consulted to develop recommendations for a drilled pier foundation system.

Considering our understanding of the owners' preferences, we recommend the building and retaining walls be founded on spread footings bearing on a layer of nonexpansive structural fill, with overexcavation of existing fill in its entirety, and removal of shallow clay and claystone materials present within 8 feet of the foundations and within 6 feet of floor slab bearing elevations. The structural fill layer is intended to provide separation between the expansive materials and thereby reduce the potential for foundation and slab movement. Increasing the thickness of this structural fill layer will further reduce the potential for uplift. The intent of this recommendation is to provide a low risk of heave or settlement of more than about 1 inch under normal conditions. Movement could be more if extreme wetting of the underlying materials occurs.

FOUNDATION RECOMMENDATIONS

The design and construction criteria presented below should be observed for a spread footing foundation system. The recommendations that follow below apply to the site buildings, retaining walls, and screen walls. The construction details should be considered when preparing project documents.

1. In order to provide relatively uniform support, we recommend the foundations bear on a minimum 3-foot-thick layer of nonexpansive structural fill. Any areas of existing fill or loose or soft material encountered at the base of the initial 3-foot overexcavation should be removed and replaced with structural fill. Additionally, at a minimum, we also recommend the native clay soils and claystone bedrock, where present within 8 feet below the proposed foundation bearing elevation, be overexcavated and replaced with nonexpansive structural fill. We should be consulted at the time of excavation to assist the contractor in determining the additional limits of overexcavation required to remove the deeper fills and shallow expansive materials that remain after the initial 3-foot overexcavation is cut. New structural fill should extend down from the edges of the foundations at a 1 horizontal to 1 vertical projection. Additional discussion with regard to lateral limits of overexcavation including floor slab and pavement areas is presented in the "Site Grading & Earthwork" section of the report.
2. Footings placed on the nonexpansive structural fill should be designed for an allowable soil bearing pressure of 2,500 psf.
3. The specifications for structural fill materials and compaction criteria are presented in the "Site Grading & Earthwork" section of the report.
4. We estimate total movement for footings designed and constructed as discussed in this section will not exceed 1 inch under normal conditions. Movement could be more if extreme wetting of the underlying materials occurs.
5. It has been our experience that unusual loading conditions can occur with precast panel construction founded on a spread footing foundation system such as continuous or strip footings, due to practices used in erecting the heavy concrete panels. The method of panel placement can greatly influence the actual loading conditions on the footing during construction. A common practice is to support the panels with narrow shim stacks placed near the outside ends of each panel. This results in a concentrated load condition at each shim stack. The load on the footing is actually compounded by placement of shim stacks on adjoining panels, resulting in point loading of the foundation at ends of panels. Depending on the panel size and support details, the actual point load can greatly exceed the allowable bearing pressure and can result in localized, non-uniform settlement resulting in undesirable movement at the joints between panels. This condition can be aggravated if the foundation subgrade is allowed to be wetted from water ponding adjacent to footings, which can result in unacceptable panel settlement.

The panel erection contractor should be made aware of the potential for accelerated or non-uniform movement and measures should be taken to reduce the potential for such movement to occur. Measures that can be considered include placement of more shim stacks between the panel and footing and placement and curing of the dry pack mortar prior to releasing the entire load onto the footing.

6. Footings should have a minimum width of 16 inches for continuous footings and 24 inches for isolated pads.
7. Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 30 inches below the exterior grade is typically used in this area.
8. Criteria for the lateral resistance of a spread footing placed on native granular materials or properly compacted structural fill is presented in the “Foundation and Loading Dock Walls” section of this report.
9. Continuous foundation walls should be reinforced top and bottom to span an unsupported length of at least 12 feet.
10. Granular foundation soils should be compacted with a smooth vibratory compactor prior to placement of concrete.
11. The base of the structural fill layer is anticipated to be at or below the water level in the eastern portion of the building footprint, as well as portions of Wall C. Therefore, it may be necessary to dewater some of the excavation during construction.
12. A representative of the geotechnical engineer should observe all footing excavations prior to fill and concrete placement.

SEISMIC DESIGN CRITERIA

Using estimated shear wave velocities for the subgrade materials encountered based on standard penetration testing, calculations indicate a design Site Class C per the International Building Code (IBC). Based on the subsurface profile and the anticipated ground conditions, liquefaction is not a design consideration.

FLOOR SLABS

Floor slabs present a difficult problem where moderately to highly expansive materials are present near floor slab elevation because sufficient dead load cannot be imposed on them to resist the uplift pressure generated when the materials are wetted and expand. The most positive method to avoid damage as a result of floor slab movement is to construct a structural floor above a well-ventilated crawl space. Based on the moisture-volume change characteristics of the materials encountered, we believe slab-on-ground construction may be used, provided the risk of distress resulting from slab movement is recognized and accepted by the owner and the following measures are taken to reduce the damage which could result from movement should the underslab materials be subjected to moisture changes.

1. Floor slabs should be supported on the on-site native granular soils and/or on a layer of nonexpansive structural fill. Existing fill, where encountered below the floor slab, should be overexcavated and replaced with suitable fill. Clay soils and claystone bedrock present within 6 feet of the proposed floor slab elevation should be overexcavated and replaced with nonexpansive structural fill. Increasing the thickness of the structural fill layer will further reduce the potential for slab movement.
2. The specifications for structural fill materials and compaction are presented in the "Site Grading & Earthwork" section of the report.
3. Floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement.
4. Interior nonbearing partitions resting on floor slabs should be provided with slip joints so that, if the slabs move, the movement cannot be transmitted to the upper structure. This detail is also important for wallboards, stairways and doorframes. Slip joints, which will allow at least 2 inches of vertical movement, are recommended.

If wood or metal stud partition walls are used, the slip joints should be placed at the bottoms of the walls so differential slab movement will not damage the partition wall. If slab bearing masonry block partitions are constructed, the slip joints will have to be placed at the tops of the walls. If slip joints are provided at the tops of walls and the floors move, it is likely the partition walls will show signs of distress, such as cracking. An alternative, if masonry block walls or other walls without slip joints at the bottoms are required, is to found them on footings and to construct the slabs independently of the foundation. If slab bearing partition

walls are required, distress may be reduced by connecting the partition walls to the exterior walls using slip channels.

Floor slabs should not extend beneath exterior doors or over foundation grade beams, unless saw cut at the beam after construction.

5. Floor slab control joints should be used to reduce damage due to shrinkage cracking. Joint spacing is dependent on slab thickness, concrete aggregate size and slump, and should be consistent with recognized guidelines such as those of the Portland Cement Association (PCA) or American Concrete Institute (ACI). The joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use.
6. If moisture-sensitive floor coverings will be used, mitigation of moisture penetration into the slabs, such as by use of a vapor barrier, may be required. If an impervious vapor barrier membrane is used, special precautions will be required to reduce the potential for differential curing problems which could cause the slabs to warp. Section 302.1R of the ACI Manual of Concrete Practice addresses this topic.
7. All plumbing lines should be tested before operation. Where plumbing lines or other slab protrusions enter through the floor, a positive bond break should be provided. Flexible connections should be provided for slab-bearing mechanical equipment.

The precautions and recommendations itemized above will not prevent the movement of floor slabs if the underlying expansive materials are subjected to alternate wetting and drying cycles. However, the precautions should reduce the damage if such movement occurs.

FOUNDATION AND RETAINING WALLS

Foundation walls and retaining structures which are laterally supported and can be expected to undergo only a moderate amount of deflection should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 55 pcf for backfill consisting of the on-site granular soils, or 50 pcf if a imported CDOT Class I structural backfill is used. Cantilevered retaining structures which can be expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 45 pcf for backfill consisting of the on-site granular soils, or 40 pcf for CDOT Class I structural backfill.

All foundation and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent buildings, traffic, construction materials and equipment. The pressures recommended above assume drained conditions behind the walls and a horizontal backfill surface. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on a foundation wall or retaining structure.

The lateral resistance of a foundation or retaining wall footing placed on undisturbed native granular soils or properly compacted structural fill material will be a combination of the sliding resistance of the foundation on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings may be calculated based on an allowable coefficient of friction of 0.3. Passive pressure against the sides of the footings may be calculated using an allowable equivalent fluid unit weight of 180 pcf.

The onsite soils, minus any clay and claystone, are suitable for use as wall backfill. Imported granular wall backfill, if used, should meet the requirements of a CDOT Class I structural backfill with less than 20% passing the No. 200 sieve. Proposed material should be approved by the geotechnical engineer prior to use.

The granular backfill behind foundation and retaining walls should be sloped from the base of the wall at an angle of at least 45 degrees from the vertical. Backfill should be placed in uniform lifts and compacted to the criteria presented in the "Site Grading & Earthwork" section of the report. Care should be taken not to overcompact the backfill since this could cause excessive lateral pressure on the walls. Some settlement of deep foundation wall backfills will occur even if the material is placed properly.

WATER SOLUBLE SULFATES

The concentration of water-soluble sulfates measured in samples obtained from the supplemental exploratory borings and from our previous study were approximately 0.36% or less. These concentrations of water soluble sulfates represent Class 0 to Class 2 severity exposures to sulfate attack on concrete exposed to these materials. The degree of attack is based on a range of Class 0, Class 1, Class 2, and Class 3 severity exposure as presented in ACI 201. Concrete meeting the criteria for Class 2 sulfate resistance is recommended for structures exposed to the on-site soils, as defined by ACI 201.2 R-10, Section 2.2.7, or Section 601.4 of the CDOT Standard Specifications.

SUBSURFACE DRAINS

Building Underdrain: Portions of the overexcavation zone may extend near or below the groundwater level. In addition, the overexcavation recommended may create a localized “bathtub” in which water may collect and cause the expansive bedrock to swell and cause distress. We therefore recommend the perimeter of the eastern portion of the building requiring overexcavation of bedrock below foundations be protected by an underdrain system. The underdrain system should consist of 4-inch diameter perforated Schedule 40 PVC pipe, surrounded by a minimum of 1 foot of free-draining gravel, around the perimeter of the bottom of the excavation. The base of the overexcavation should be graded to slope at a minimum 0.5% towards the drain lines. To collect seepage of permeable zones within bedrock, the underdrain system should also include a blanket drain along the face of the excavated cut slopes where bedrock is encountered. The blanket drain should consist of a 1-foot-thick layer of free draining gravel wrapped with filter fabric and hydraulically connected to the perimeter drain. The blanket drain should extend up to within 3 feet of the pavement grade or ground surface. Geocomposite drainage board may be used in lieu of the blanket drain. Relatively impervious fill should be used above the blanket drain to reduce migration of surface water into underdrain. A conceptual drain detail is presented on Fig. 18.

Rigid schedule 40 PVC pipe is recommended, as flexible pipes can be easily crushed during construction operations and are hard to detect. We also recommend installing occasional cleanouts to enable future inspections and maintenance of the drain lines. The drain line should be sloped at a minimum 0.5% slope to positive outlets where water can be removed by pumping or gravity flow. The underdrain line and gravel should be wrapped with suitable filter geotextile such as Mirafi 140N or equivalent. Free-draining gravel should consist of maximum 1½ inch size aggregate with less than 30% passing the No. 4 sieve and less than 5% passing the No. 200 sieve.

Pavement Edge Drain: Previous study suggest the groundwater may be near the pavement grade. Although the measured groundwater levels were lower/deeper during this supplemental study, it is our opinion seasonal perched groundwater conditions can develop in proximity to the pavement grade, particularly where the bedrock is shallow along the northeast building corner. This water can saturate the materials under the pavement, causing them to lose strength and result in pavement failure. The shallow groundwater may contribute to pavement distress. Because of this, we recommend a subsurface interceptor drain be installed along the upslope side of the north and east sides of the building adjacent to the pavement areas where claystone and/or sandstone bedrock is present at depths of 2 feet or less from the proposed pavement subgrade. The drain is intended to reduce the amount of subsurface water which enters the material beneath the pavement surface. If

the retaining wall designs include a drain that extends at least 2 feet below the pavement subgrade, a pavement edge drain would not be necessary.

The drains should be installed so they are 2 feet below the pavement subgrade. The drains should consist of a minimum 4-inch-diameter rigid perforated PVC pipe placed in the bottom of a trench and surrounded above the invert level with free-draining gravel. The free-draining gravel should extend up to the bottom of the curb and gutter or base of pavement and should be surrounded with filter fabric. The drains should be sloped to a gravity outlet. If the drain is not located below the pavement, the backfill above the gravel should consist of a relatively impervious soil. A pavement edge drain detail is presented on Fig. 19.

SURFACE DRAINAGE

Proper surface drainage is very important for acceptable performance of the building and site structures during construction and after the construction has been completed. Drainage recommendations provided by local, state and national entities should be followed based on the intended use. The following recommendations should be used as guidelines and changes should be made only after consultation with the geotechnical engineer.

1. Excessive wetting or drying of the foundation and slab subgrades should be avoided during construction.
2. Care should be taken when compacting around foundation walls and underground structures to avoid damage to the structure.
3. The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 6 inches in the first 10 feet in unpaved areas. Site drainage beyond the 10-foot zone should be designed to promote runoff and reduce water infiltration. A minimum slope of 3 inches in the first 10 feet is recommended in the paved areas. These slopes may be changed as required for handicap access points in accordance with the Americans with Disabilities Act.
4. Ponding of water should not be allowed in backfill material or within 20 feet of the foundation walls, whichever is greater.
5. Roof downspouts and drains should discharge well beyond the limits of all backfill.

6. Lawn sprinkler heads and landscaping which requires typical irrigation and should be located at least 10 feet from foundation walls. Irrigation schemes are available which allow placement of lightly irrigated landscape near foundation walls in moisture sensitive soil areas. Drip irrigation heads with main lines located at least 10 feet from the foundation walls are acceptable provided irrigation quantities are limited.
7. Plastic membranes should not be used to cover the ground surface adjacent to foundation walls. A pervious geotextile may be used to inhibit weed growth.

SITE GRADING & EARTHWORK

Temporary Excavations: All excavations should be in accordance with OSHA, state and local requirements. The contractor should follow appropriate safety precautions. In accordance with OSHA guidelines, the silty sand overburden soils above the groundwater level classify as a Type C material, and the clayey sand, clay and bedrock classifies as Type B. Due to the variability of the subsurface soils encountered, we recommend a Type C be considered for the overburden soils. Temporary unretained excavations in Type C materials should have slopes no steeper than 1½:1 (H:V), and Type B materials should have slopes no steeper than 1:1, unless shored. Flatter slopes will be required where groundwater seepage is encountered. We anticipate slopes of 2:1 to 3:1 will be required in these areas. OSHA regulations require that excavations greater than 20 feet in depth be designed by a professional engineer. A contractor's competent person should make decisions regarding cut slopes.

Excavation Considerations: In our opinion, the near surface bedrock and overburden soils encountered in the exploratory borings drilled for this study can be excavated with heavy-duty construction equipment with rippers. It is possible that localized, harder lenses of bedrock may be encountered within the excavation in other areas. If harder rock is encountered, hydraulic chiseling may be required, particularly in confined trench excavations.

Depending on the depths of excavation and the season, excavations may extend near or even below the groundwater level. We anticipate dewatering can be accomplished using a system of trenches and sumps around the perimeter of the base of the excavation. The trenches should be sloped to the sumps where water can be pumped from the excavation. If it is necessary to dewater granular soils in excavations above the bedrock, methods that lower the groundwater level below the base of the excavation should be used to avoid loss of supporting capacity of the soils. Depending on the depth of overexcavation below the groundwater level, the use of well points may also be feasible. The contractor may have other methods for accomplishing dewatering. Dewatering must be maintained

through the time period the excavation is open. The dewatering system should be properly designed, installed, and maintained by an experienced dewatering contractor.

Cut and Fill Slopes: We recommend the following criteria be used when preparing site grading plans. Permanent cut and fill slopes should not be steeper than 3:1 (horizontal to vertical) and should not exceed 30 feet in height. Slopes will generally be stable at 2:1; however, 2:1 slopes will be prone to increased surface erosion and it will be difficult to maintain vegetation on them. Cut and fill slopes of greater heights are feasible; however, they should be investigated on an individual basis. The risk of slope instability will be significantly increased if seepage is encountered in cuts. If seepage is encountered in permanent excavations, an investigation should be conducted to determine if the seepage will adversely affect the cut stability. Fills should be benched into hillsides steeper than 4:1.

Good surface drainage should be provided for all permanent cuts and fills to direct the surface runoff away from the slope faces. Cut and fill slopes and other stripped areas should be protected against erosion by revegetation or other means. Site grading should be planned to provide positive surface drainage away from all building and pavement areas.

No formal stability analyses were performed to evaluate the slopes recommended above. Published literature and our experience with similar cuts and fills indicate the recommended slopes should have adequate factors of safety. If a formal stability analysis is required, we should be notified.

Fill Material Specifications: The following material specifications are presented for fills on the project site.

1. *Structural Fill:* The on-site fill and native granular soils, and sandstone bedrock should generally be suitable for reuse as compacted fill, including structural fill beneath foundations, floor slabs, exterior flatwork and pavements. Clay and claystone should be considered unsuitable for use as structural fill. Imported structural fill, if required, should consist of nonexpansive granular soil material having a maximum of 40% passing the No. 200 sieve, and a maximum plasticity index of 15. We recognize some of the tested samples of on-site granular soils do not meet these criteria; however, it is our opinion that with proper moisture conditioning they will be suitable for reuse. Any sandstone bedrock placed as fill should only be used if it is processed into a soil like material, with a maximum particle size

of 2 inches. New fill should extend down from the edge of foundations at a minimum 1:1 horizontal to vertical projection.

2. *Reuse of Clays and Claystone Bedrock:* The clay and claystone will be expansive when placed in a compacted condition and is not suitable for use as structural fill. Placement of excavated claystone should be limited to nonstructural areas such as landscape areas to the extent practical. If necessary elsewhere, placement of clay and claystone should be limited to deeper fills, and placed at depths 8 feet or greater from the foundation bearing elevation in building/structure locations, and 2 feet or greater in pavement areas. Claystone placed as fill should only be used if it is processed into a soil like material, with a maximum particle size of 2 inches.
3. *Utility Trench Backfill:* Material excavated from the utility trenches may be used for backfill provided it does not contain unsuitable material or particles larger than 2 inches.
4. *Material Suitability:* All fill material should be free of vegetation, brush, sod, trash and debris, and other deleterious substances, and should not contain rocks or lumps having a diameter of more than 4 inches. The geotechnical engineer should evaluate the suitability of all proposed fill materials prior to placement.
5. *Subgrade Preparation:* The ground surface shall be stripped of vegetation/organics prior to fill placement. The resulting ground surface should be scarified to a depth of 12 inches, moisture conditioned as necessary, and compacted in a manner specified below for the subsequent layers of fill. Loose or unstable soils shall be removed, where present, in order to provide a stable platform prior to placement of fill.

Overexcavation: In order to provide relatively uniform support, we recommend the foundations bear on a minimum 3-foot-thick layer of nonexpansive structural fill. Any areas of existing fill or loose or soft material encountered within the base of the initial 3-foot foundation overexcavation should be removed and replaced with structural fill. Additionally, at a minimum, we also recommend the native clay soils and claystone bedrock, present within 8 feet below the proposed foundation bearing elevation and within 6 feet of floor slabs, be overexcavated and replaced with nonexpansive structural fill. We should be consulted at the time of excavation to assist the contractor in determining the additional limits of overexcavation required to remove the deeper fills and shallow expansive materials that remain after the initial 3-foot overexcavation is cut.

The overexcavation zone should extend 10 feet beyond the building where exterior flatwork is located, including sidewalks and patio areas, and where reduction of heave potential is considered critical. Depending on the amount of site grading planned, partial or no overexcavation may be needed provided there is adequate separation between the bearing elevation and the expansive materials. For pavement areas and other areas with movement sensitive exterior flatwork, we recommend a minimum 2-foot overexcavation and replacement of clays and claystone present within the proposed pavement grade outside of the 10-foot building perimeter zone described above. Based on the boring logs, it appears it may be required northeastern approximate 1/3 of the building, and the adjacent retaining walls and pavements. Provided the owner understands and accepts the potential for differential subgrade settlement and the resulting increased potential for distress, it is our opinion overexcavation of existing fill will not be necessary in pavement areas other areas with exterior concrete flatwork, as these items can typically tolerate movement and are more easily repaired.

Compaction Requirements: A representative of the geotechnical engineer should observe fill placement operations on a full-time basis. We recommend the following minimum compaction criteria be used on the project.

Area	Percentage of Standard Proctor Maximum Dry Density (ASTM D 698)	
Building Pads/Foundation Subgrade	100%	
Floor Slab Subgrade	100%	
Retaining Wall Subgrade	Depths >10'	100%
	Depths <10'	98%
Foundation/Retaining Wall Backfill	95%	
Beneath Pavement Areas/Exterior Flatwork/Utility Trenches	Depths >10'	100%
	Depths <10'	95%
Landscape and Other Misc. Overlot Fill Areas	95%	
Compaction of granular soils should be achieved at a moisture content within +/- 2% of the optimum. Clay soils should be placed at a moisture content within 0% to +4% of the optimum.		

Subgrade Stabilization: Unstable subgrade may be encountered during subgrade preparations. Unstable soils may be stabilized by scarifying/ripping the subgrade and allowing it to dry, or by

overexcavation and replacement of the subgrade with suitable, imported, angular, well-graded materials. Other alternatives include the use of Type 2 biaxial geogrid reinforcement in combination with a layer of Class 6 aggregate base course. It has been our experience that the use of a crushed concrete product meeting a Class 6 gradation can perform well when trying to achieve stabilization. Specific stabilization requirements should be evaluated at the time of construction. We are unable to accurately predict or quantify areas where unstable subgrade conditions may occur, however, we recommend this work activity, if required, be included as a line item in the bid schedule to avoid cost overruns.

PAVEMENT DESIGN

Subgrade Materials: The existing subgrade soils encountered during our studies classified as A-1-a, A-1-b, A-2-4, A-2-7, A-4, A-5, A-6, A-7-5 and A-7-6 with group indices ranging from 0 to 45 in accordance with the American Association of State Highway Transportation Officials (AASHTO) classification. The majority of the subgrade soils in the parking lot and loading area south of the building consist of granular soils. The majority of the soils that will be exposed in and around the east end of the building perimeter will be A-6 or A-7-6 soils, which have a lower strength than the granular soils. Based on the laboratory test results and our experience with similar subgrade materials, an R-value of 15 and a resilient modulus of 4,195 psi were assumed for design of flexible pavements, and a subgrade modulus of 125 pci was assumed for rigid pavements. This assumption will require that clays and claystone present within 2 feet of pavement subgrade elevation be overexcavated and replaced with suitable nonexpansive soils.

Design Traffic: We have assumed the traffic loading information provided for the 2007 study remain applicable, which included the following 20-year 18-kip equivalent single axle load application (ESALs): 36,500 for the parking lot area with traffic restricted to autos, 73,000 for the fire lane, and 584,000 for the access drives, loading dock slab and other areas where truck traffic will be present. If it is determined that actual traffic is significantly different, we should be contacted to reevaluate the pavement thickness design.

Pavement Sections: The recommended sections were determined using the DARWin 3.01 pavement design software based on the 1993 AASHTO pavement design procedures. Based on the subgrade conditions encountered and the traffic information provided, we recommend the following pavement sections:

Location	Minimum Pavement Section Thickness (inches)		
	Portland Cement Concrete	Full-Depth Asphalt	Composite Asphalt over Base Course
Parking Lot, Autos Only	6	5.5	4 over 6
Fire Lane	6.5	6	4.5 over 6
Access Drive Lanes & Areas w/Truck Traffic	7	8	6 over 8

We recommend the loading dock area and areas where truck turning movements are concentrated, such as at trash pickup areas, be paved with a minimum 7 inches of Portland cement concrete rather than one of the asphalt alternatives. The use of a flexible pavement in these areas could result in pavement fatigue cracking and/or rutting/shoving of the pavement due to the concentrated wheel loads.

Subgrade Preparation: Fill placed for support of pavements should meet the material and compaction requirements for structural fill presented in the “Site Grading & Earthwork” section of this report. Prior to placing compacted fill or pavement materials, the exposed subgrade soils should be scarified to a depth of at least 12 inches, moisture conditioned, and compacted according to the specifications in the “Site Grading & Earthwork” Section of this report.

Overexcavation of Clay and Claystone: To reduce the potential magnitude of pavement heave and distress caused by swelling of the shallow clays and claystone bedrock, we recommend these materials be removed and replaced with nonexpansive fill where encountered within 2 feet of the pavement grade. At the base of the over-excavation, the entire subgrade area should be scarified to a depth of 12 inches, moisture conditioned as necessary, and compacted to the criteria presented in the “Site Grading & Earthwork” section. Increasing the depth of moisture conditioning would further reduce the magnitude of potential movements.

Based on the boring logs, it appears it may be required for pavement in and around the northeastern approximate 1/3 of the building. Depending on the amount of site grading planned, partial or no over-excavation may be applicable provided there is adequate separation from the expansive materials.

Proof Roll: Before paving, the subgrade should be proof rolled with a heavily loaded, pneumatic-tired vehicle. The vehicle should have a gross vehicle weight of at least 50,000 pounds with a

loaded single axle weight of 18,000 pounds and a tire pressure of 100 psi. Areas which deform excessively under heavy wheel loads are not stable and should be removed and replaced with suitable material to achieve a stable subgrade prior to paving or placement of base course.

Drainage: The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of the pavement. Drainage design should provide for the removal of water from paved areas and prevent the wetting of the subgrade soils. Recommendations for a pavement edge drain are included in the "Subsurface Drains" section of the report.

Pavement Materials: The asphalt pavement should consist of a bituminous material which meets the requirements of the Pikes Peak Region Asphalt Paving Specifications. Given the assumed traffic loading, we recommend the mix have a binder grade of PG 58-28 or PG 64-22, and a design gyrations (Ndes) of 75. In the event that a PG 64-22 asphalt binder is used in the mix, the asphalt section will provide adequate structural support but will be subject to a higher potential for low temperature related transverse cracking. The mix grading should consist of a Grading S for the lower lifts, and a grading SX for the top lift. Grading S may also be acceptable for the top lift.

Aggregate base course should be a Class 6 material conforming to the requirements presented in Section 703.03 of the CDOT Standard Specifications for Road and Bridge Construction.

Concrete pavement should meet the requirements of a Class P Mix, per Section 601 of the CDOT Standard Specifications, and should be based on a mix design established by a qualified engineer. The concrete should contain transverse joints not greater than 12 to 15 feet on centers and longitudinal joints no greater than 14 feet. The joints should be hand formed, sawed or formed by premolded filler. The joints should be at least 1/4 of the slab thickness. Expansion joints should be provided at the end of each construction sequence and between the concrete slab and adjacent structures. Expansion joints where required, should be filled with a 1/2 inch-thick asphalt impregnated fiber. Concrete should be cured by protecting against loss of moisture, rapid temperature changes and mechanical injury for at least three days after placement. The concrete sections presented above are assumed to be unreinforced. Providing dowels at construction joints would help reduce the risk of differential movements between panel sections. Providing a grid mat of deformed rebar or welded wire mesh within the concrete pavement section would assist in mitigating corner breaks and differential panel movements. If a rebar mat is installed, we recommend that the bars be placed in the lower half of the pavement section. Also, if reinforcing is

used, we have commonly seen No. 4 rebar placed at 24-inch center in each direction, however, we recommend that a structural engineer evaluate the placement and spacing of rebar if needed.

Maintenance: Periodic maintenance of paved areas is critical to achieve the design life of the pavement. Crack sealing should be performed annually as new cracks appear. Chip seals, fog seals, or slurry seals applied at approximate intervals of 3 to 5 years are usually necessary for asphalt. As conditions warrant, it may be necessary to perform patching and overlay at approximate 10-year intervals.

DESIGN AND SUPPORT SERVICES

Kumar & Associates, Inc. should be retained to review the project plans and specifications for conformance with the recommendations provided in this report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project and, if necessary, perform additional studies to accommodate any changes in the proposed construction. We recommend that Kumar & Associates, Inc. be retained to provide observation and testing services to document that the requirements of the plans and specifications are being followed during construction, and to identify possible variations in subsurface conditions from those encountered in this study.

LIMITATIONS

This study has been conducted for exclusive use by the client for geotechnical related design and construction criteria for the project. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings at the locations indicated on Fig. 1 or as described in the report, our 2007 report, and the proposed type of construction. This report may not reflect subsurface variations that occur, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, rock or water conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

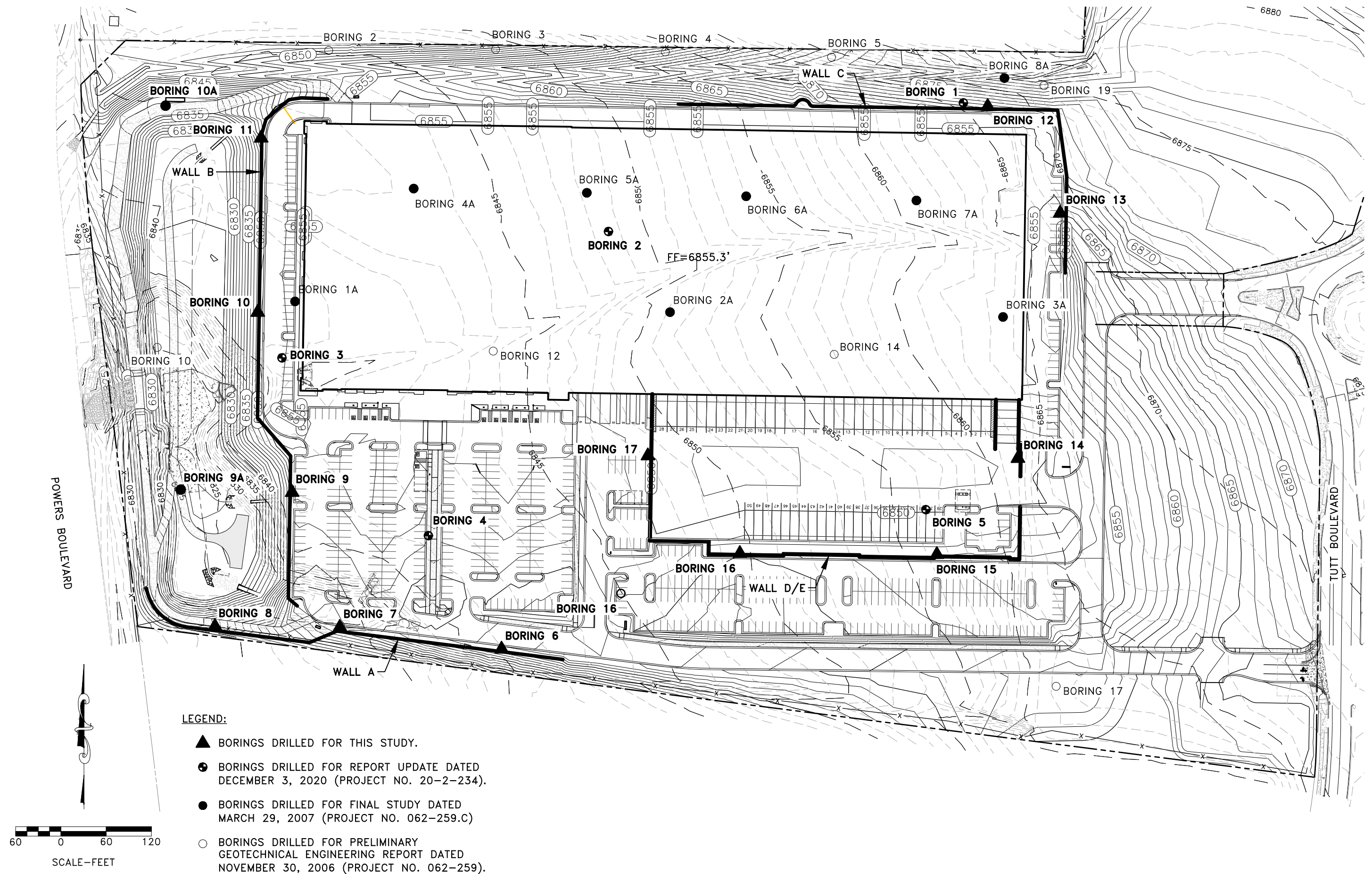
The scope of services for this project does not include any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken.

Swelling soil and bedrock materials occur on this site. Such materials are stable at their natural moisture content but will undergo high volume changes with changes in moisture content. The extent and amount of perched water beneath the building site as a result of area irrigation and inadequate surface drainage is difficult, if not impossible, to foresee.

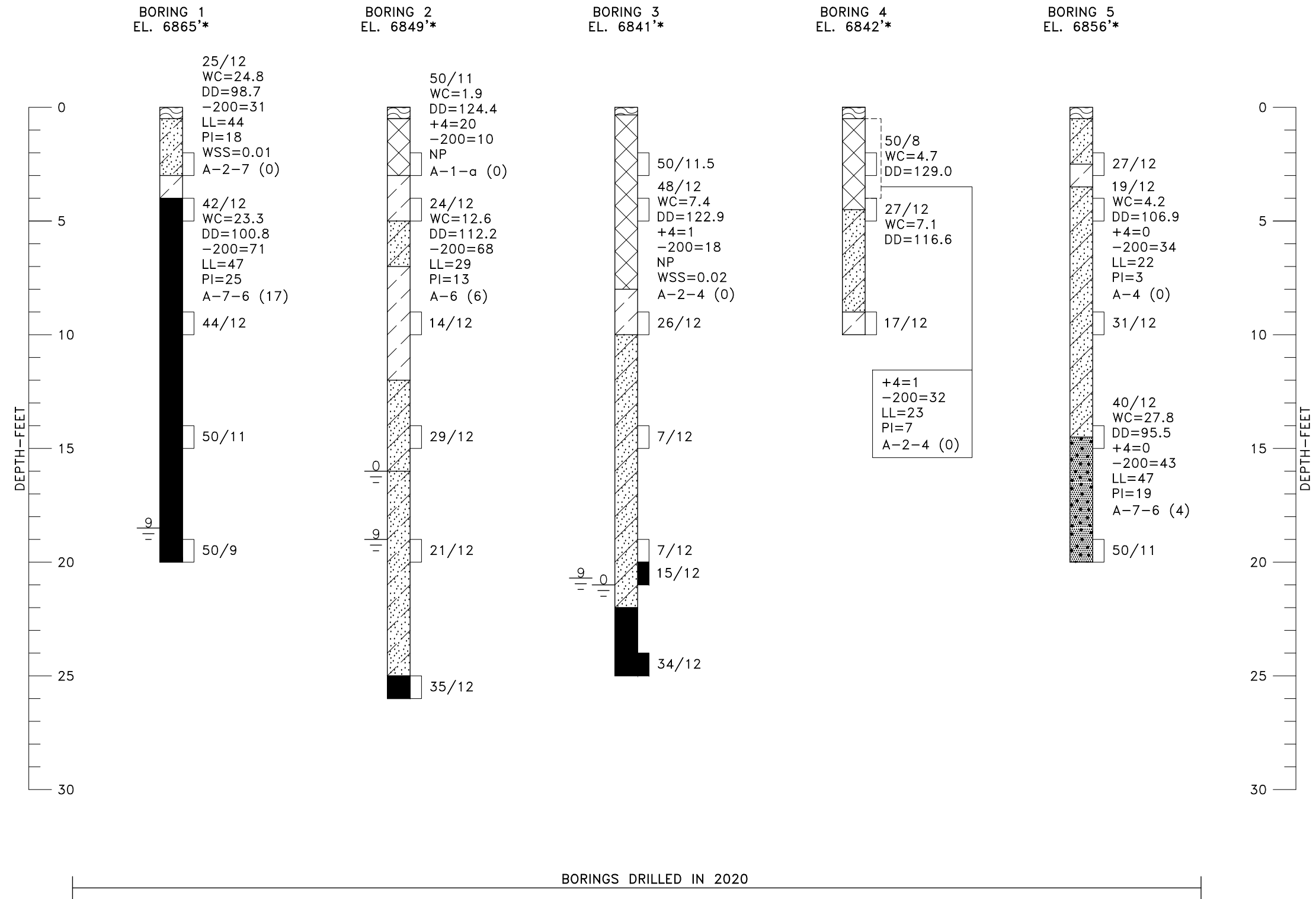
The recommendations presented in this report are based on current theories and experience of our engineers on the behavior of swelling soil/bedrock in this area. Standards of practice in this area evolve over time. The owner should be aware that there is a risk in constructing a building in an expansive soil/bedrock area. Following the recommendations given by a geotechnical engineer, careful construction practice and prudent maintenance by the owner can, however, decrease the risk of foundation movement due to expansive soils and bedrock materials.

DPC/sw

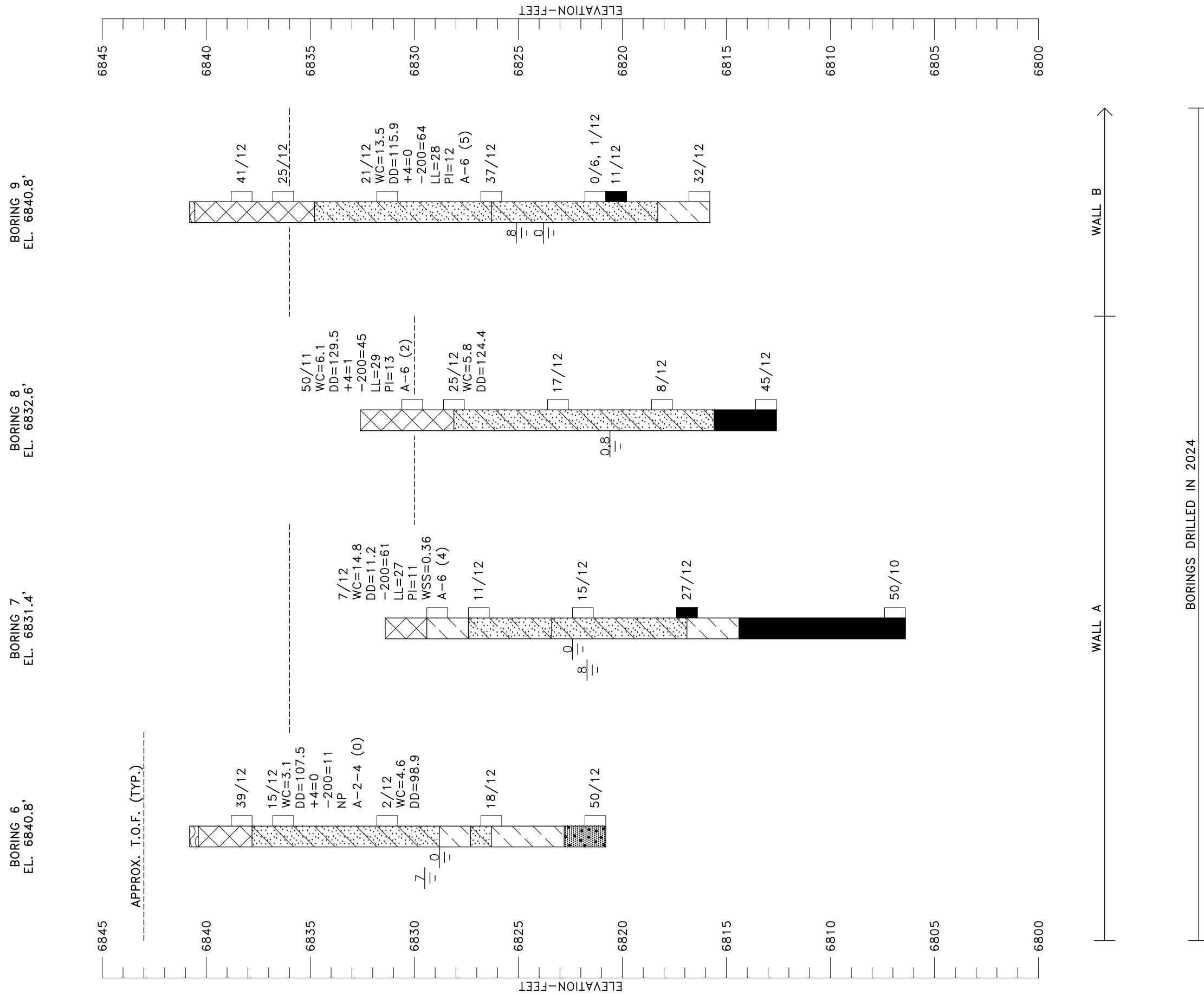
Aug 22, 24Y - 14:44pm
C:\Users\mromero\AppData\Local\Temp\AcPublish_14304\AcPublish_14304-01.dwg

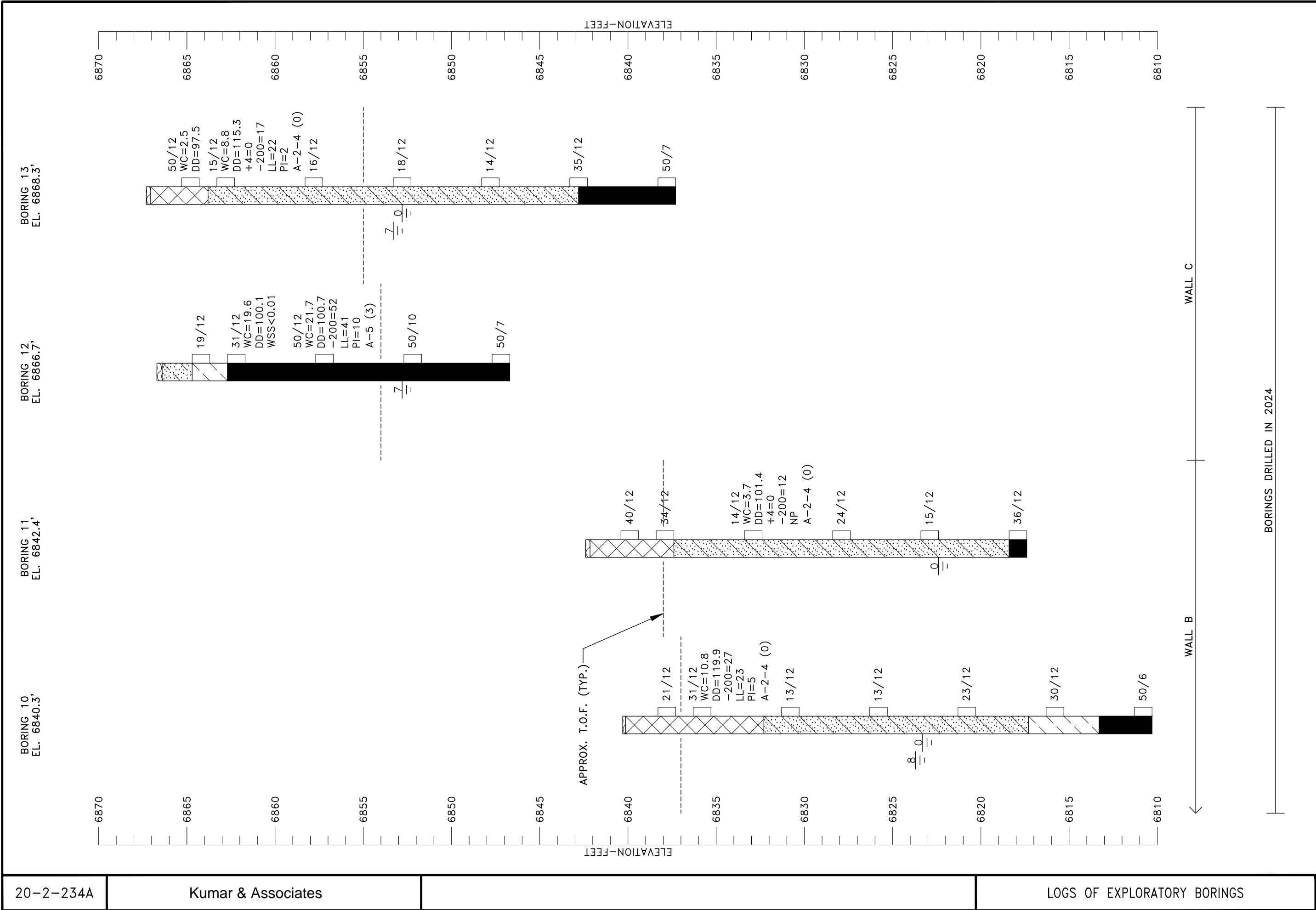


Aug 22, 24Y - 14:44pm
V:\Projects\2020\20-2-234A American Furniture Warehouse - Report Update (GEOT)\Drafting\202234A-02 to 06.dwg



* ELEVATIONS FOR BORINGS 1-5 ARE ROUGH
ESTIMATES BASED ON CURRENT DATA AVAILABLE.
TOPOGRAPHIC INFORMATION WAS NOT AVAILABLE
WHEN THE 2020 STUDY WAS COMPLETED.







BORINGS DRILLED IN 2024

Aug 22, 24Y - 14:44pm
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LEGEND



TOPSOIL.



FILL: SILTY TO CLAYEY SAND (SM, SC, SC-SM), WITH OCCASIONAL GRAVEL AND WELL-GRADED SAND WITH SILT (SW-SM), WITH OCCASIONAL ORGANICS, SLIGHTLY MOIST TO MOIST, TAN, BROWN, DARK BROWN.



SILTY SAND (SM), WITH LAYERS OF POORLY TO WELL-GRADED SAND WITH SILT (SP-SM, SW-SM), VERY LOOSE TO DENSE, SLIGHTLY MOIST TO WET, TAN TO BROWN WITH OCCASIONAL SHADES OF ORANGE.



CLAYEY SAND (SC), WITH OCCASIONAL LAYERS OF SANDY LEAN CLAY (CL), LOOSE TO MEDIUM DENSE, SLIGHTLY MOIST TO WET, BROWN AND GRAY, WITH OCCASIONAL SHADES OF ORANGE.



LEAN CLAY (CL), WITH VARIED AMOUNTS OF SAND AND SILT, MEDIUM STIFF TO HARD, SLIGHTLY MOIST TO MOIST, BROWN TO GRAY.



CLAYSTONE BEDROCK, OCCASIONALLY SANDY, MEDIUM HARD TO VERY HARD, MOIST, BROWN, OLIVE-BROWN, AND GRAY.



SANDSTONE BEDROCK, CLAYEY, NON-CEMENTED, MEDIUM HARD TO HARD, MOIST, BROWN, OLIVE-BROWN, AND GRAY.



DRIVE SAMPLE, 2-INCH I.D. CALIFORNIA LINER SAMPLE.



DRIVE SAMPLE, 1 3/8-INCH I.D. SPLIT SPOON STANDARD PENETRATION TEST.



DISTURBED BULK SAMPLE.

25/12

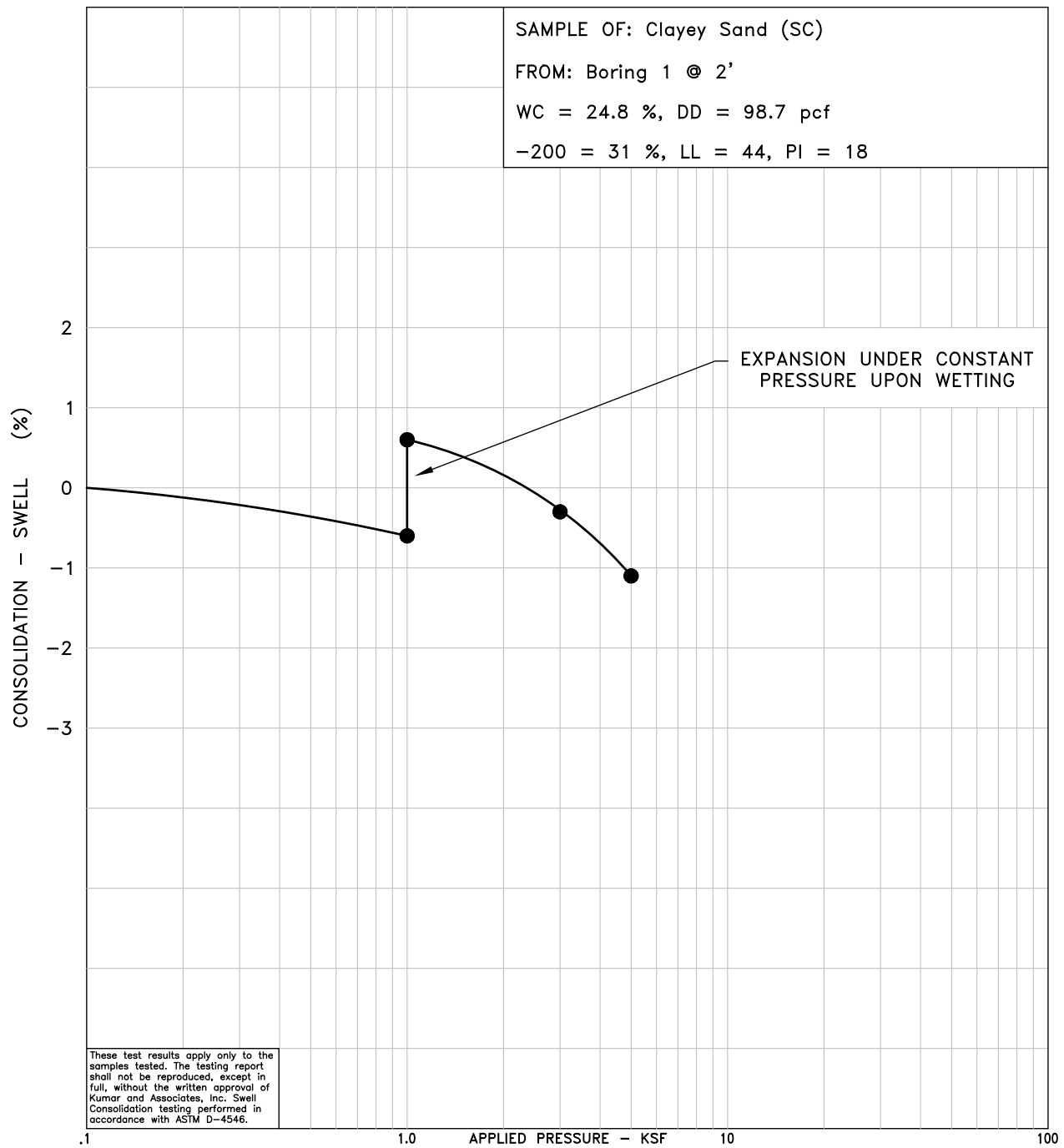
DRIVE SAMPLE BLOW COUNT. INDICATES THAT 25 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

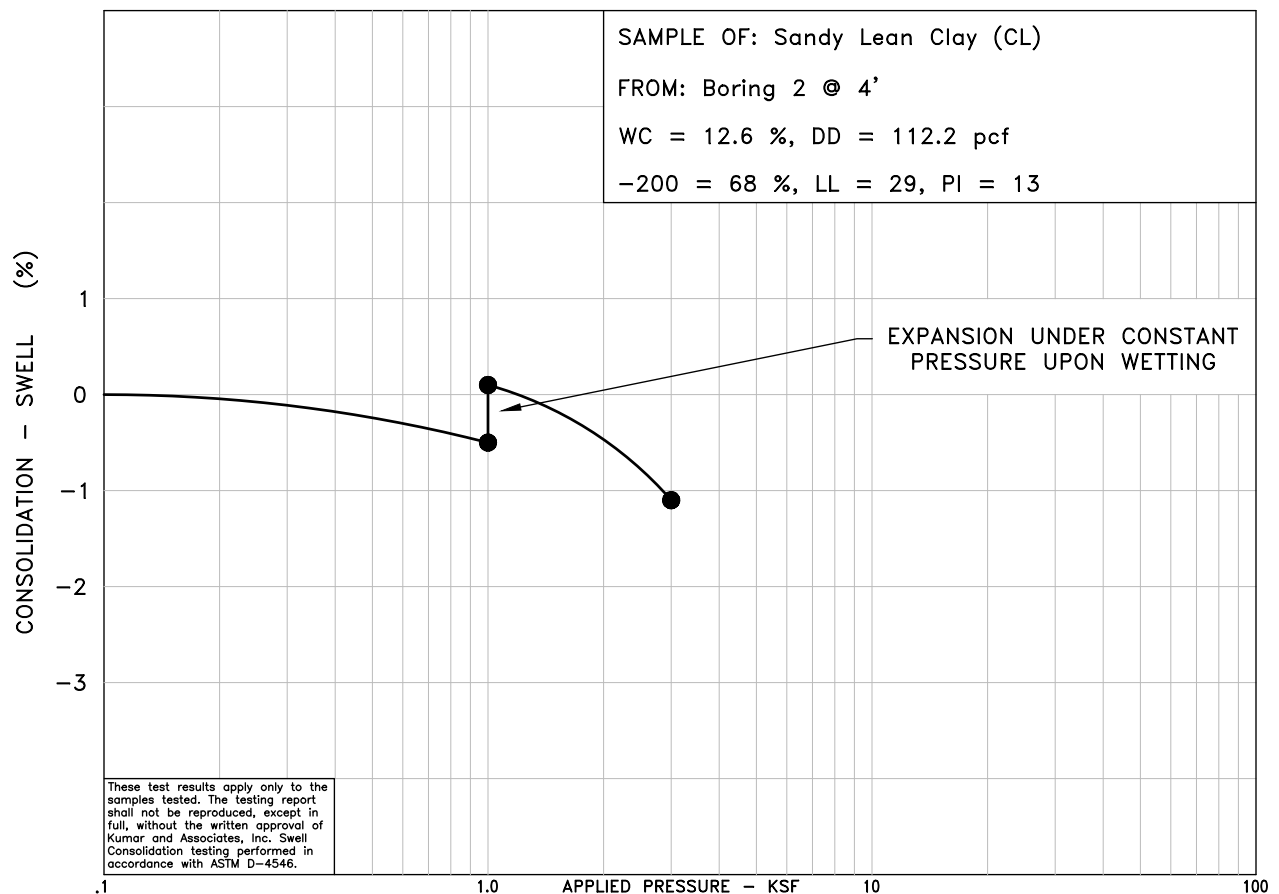
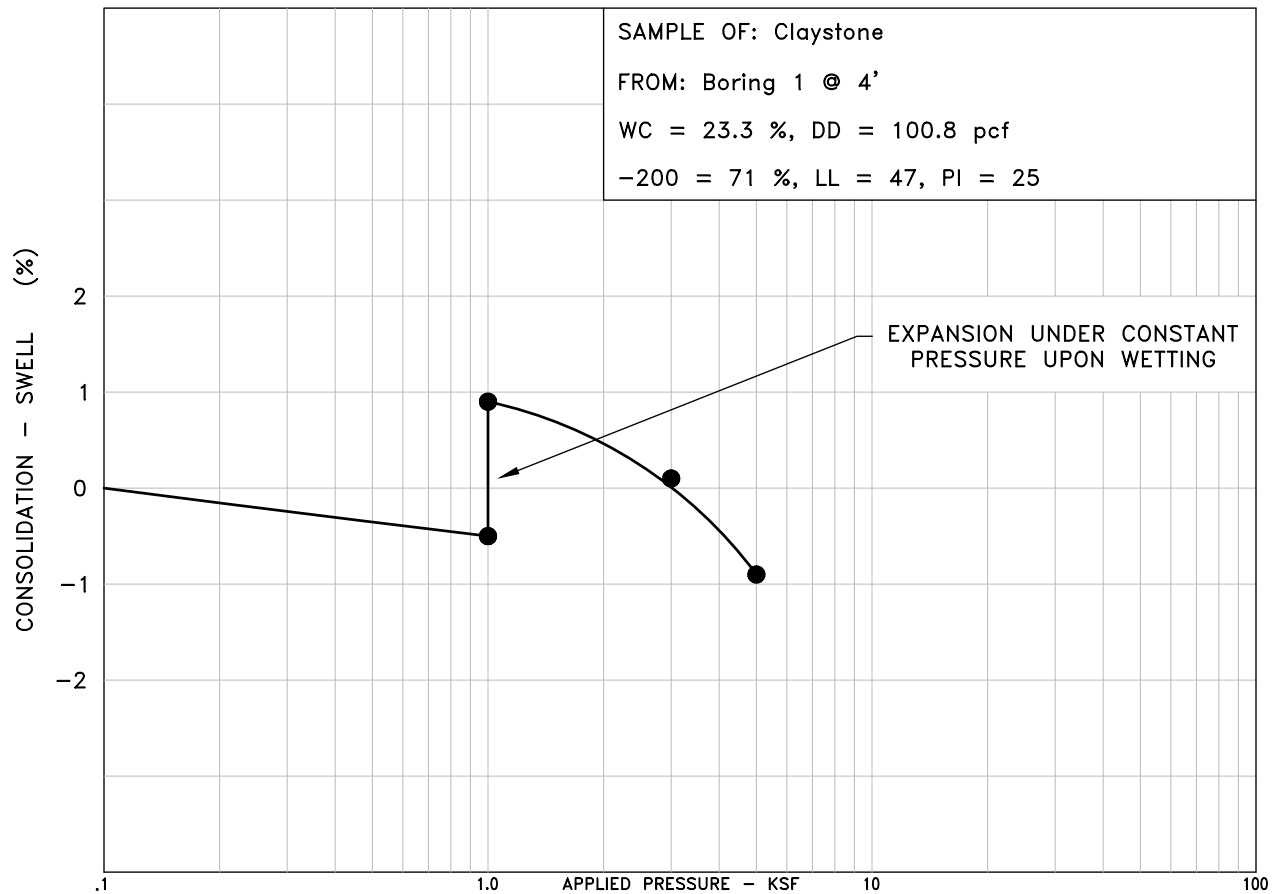


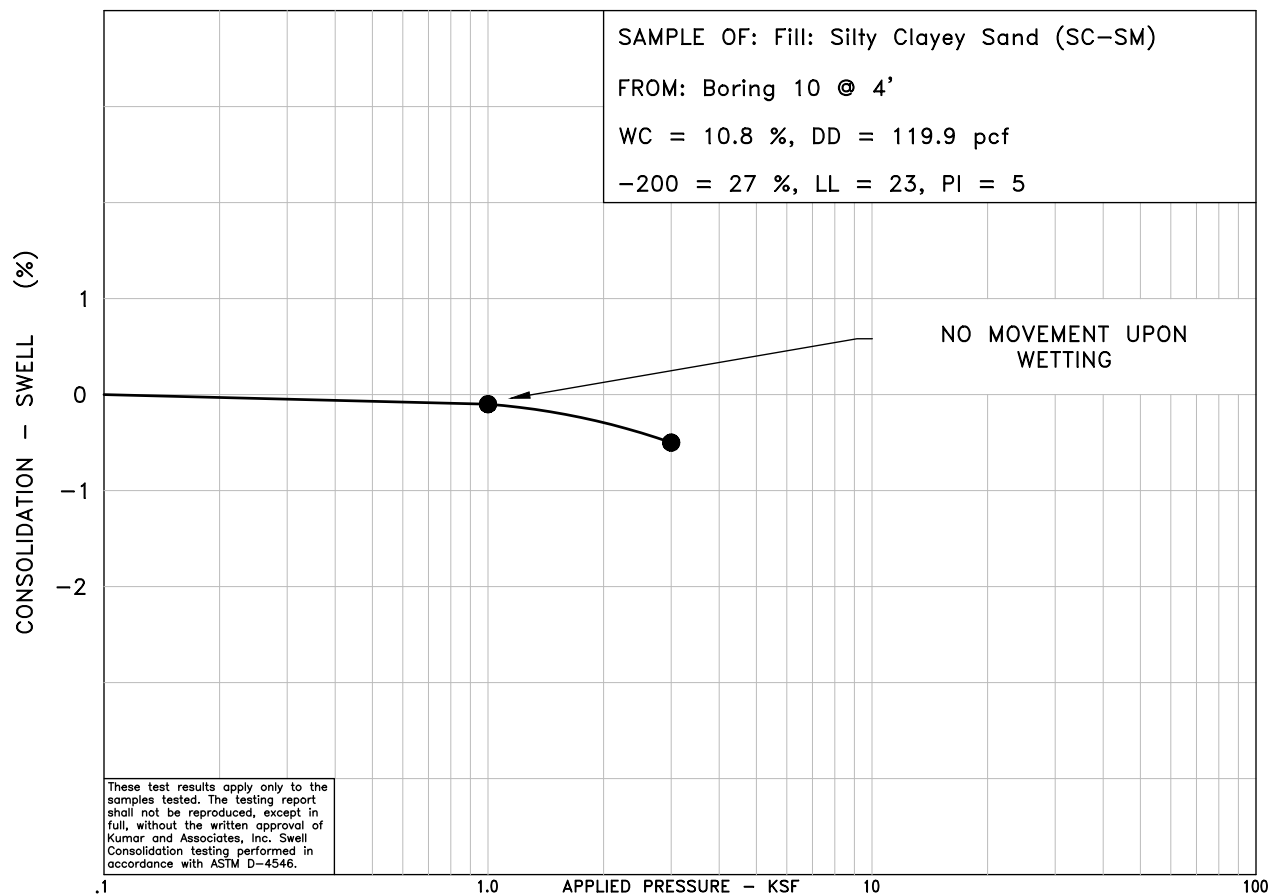
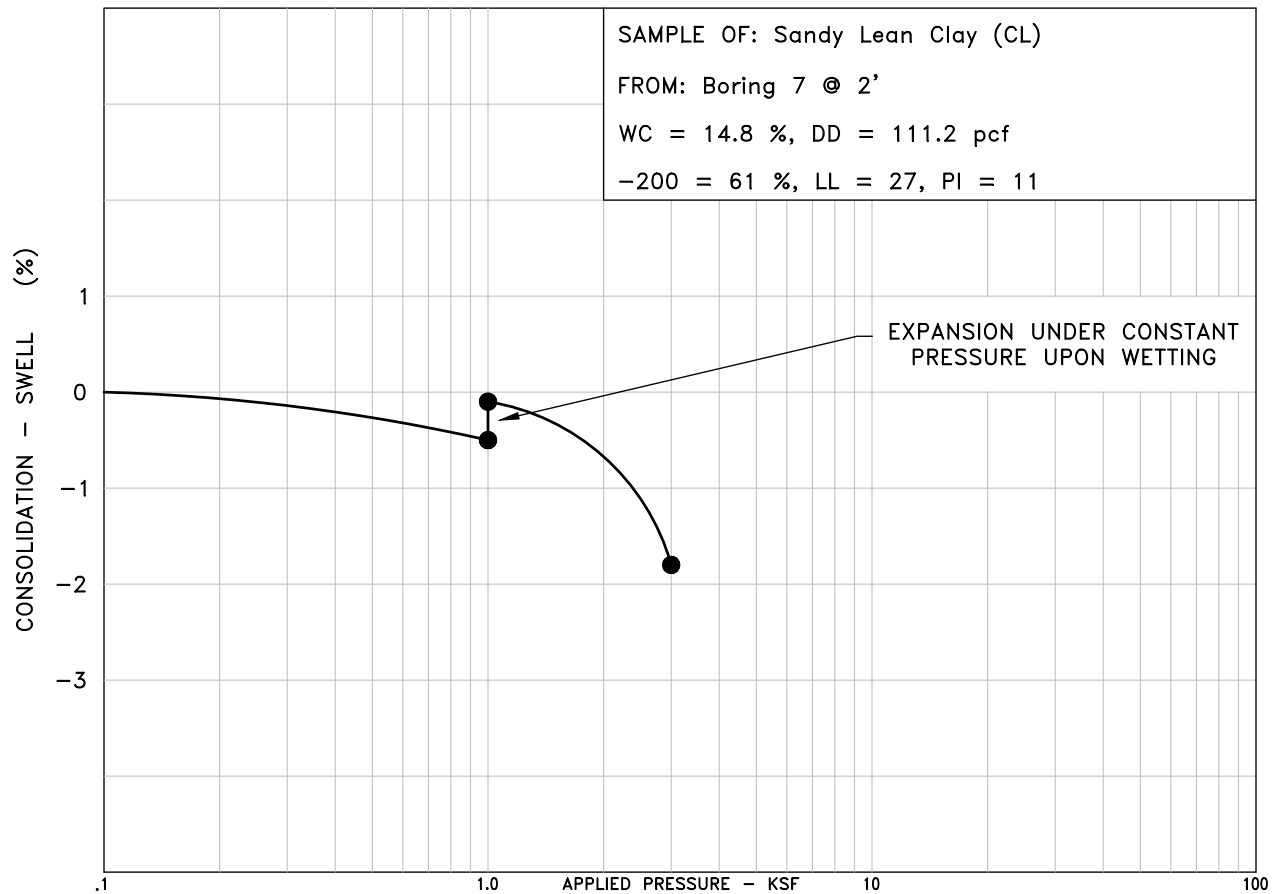
DEPTH TO WATER LEVEL AND NUMBER OF DAYS AFTER DRILLING MEASUREMENT WAS MADE.

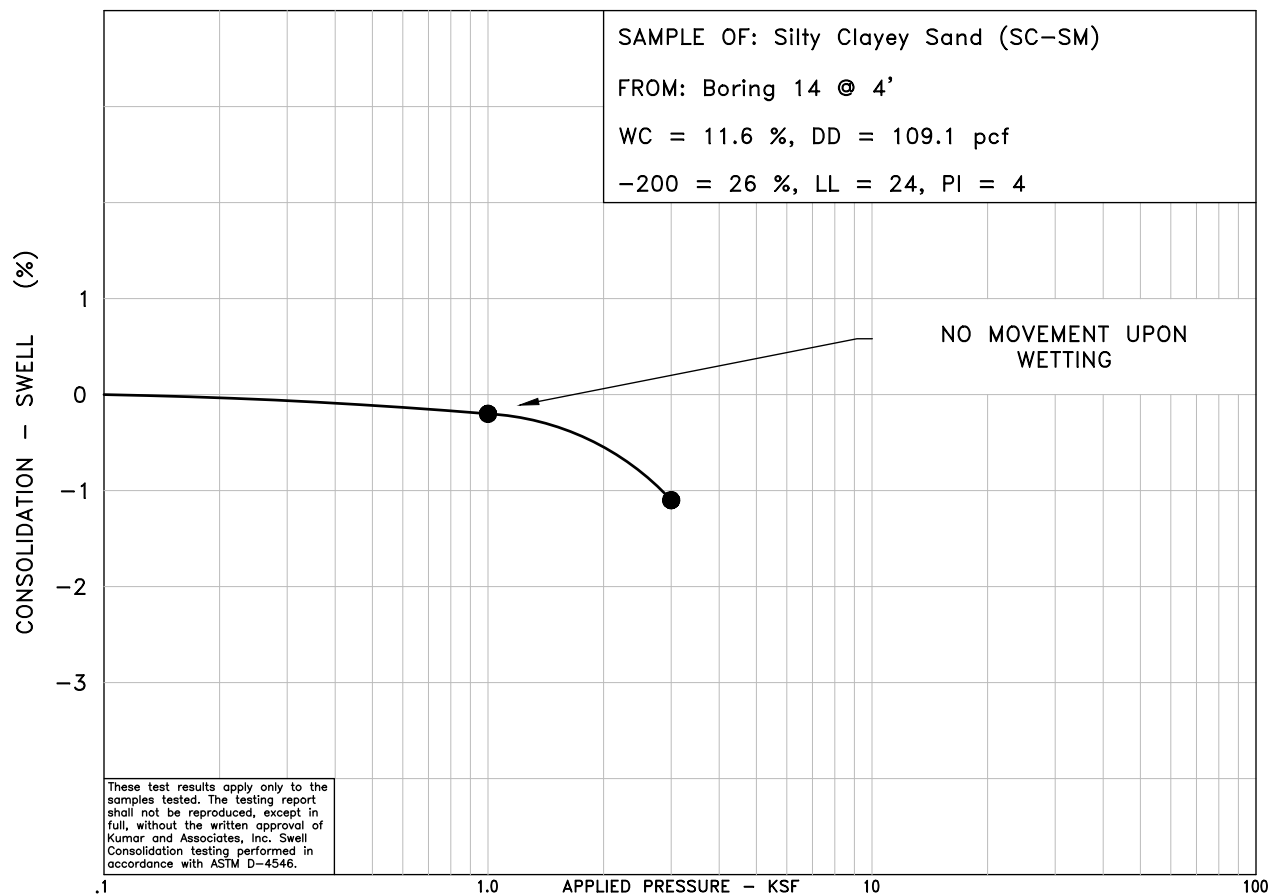
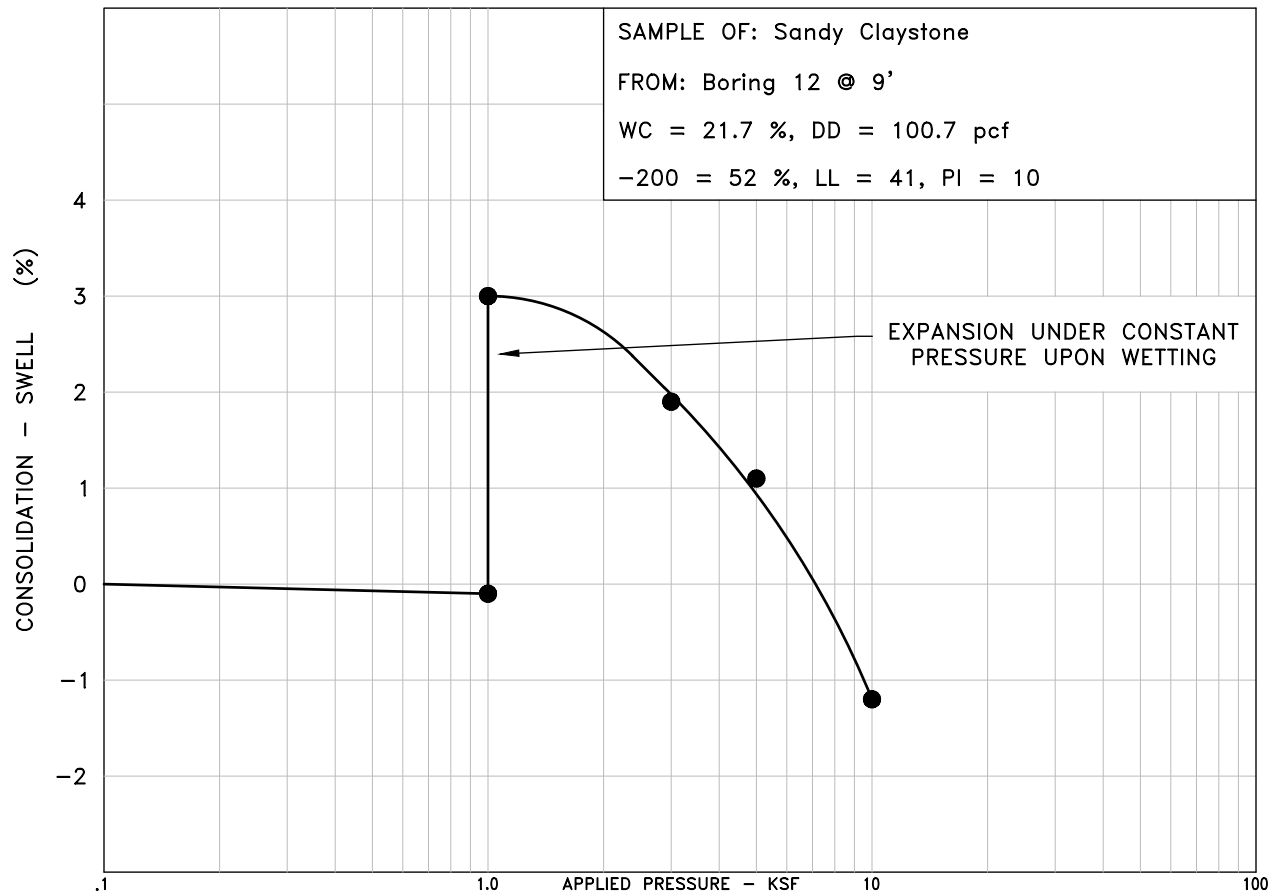
NOTES

1. BORINGS 1 THRU 5 WERE DRILLED ON NOVEMBER 16, 2020 AND BORINGS 6 THRU 17 WERE DRILLED BETWEEN AUGUST 1st AND 2nd, 2024. THE EXPLORATORY BORINGS WERE DRILLED WITH A 4-INCH-DIAMETER CONTINUOUS-FLIGHT POWER AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE OBTAINED BY INTERPOLATION BETWEEN CONTOURS ON THE SITE PLAN PROVIDED.
4. THE EXPLORATORY BORING LOCATIONS AND ELEVATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.
7. LABORATORY TEST RESULTS:
WC = WATER CONTENT (%) (ASTM D2216);
DD = DRY DENSITY (pcf) (ASTM D2216);
+4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D6913);
-200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D1140);
LL = LIQUID LIMIT (ASTM D4318);
PI = PLASTICITY INDEX (ASTM D4318);
NP = NON-PLASTIC (ASTM D 4318);
WSS = WATER SOLUBLE SULFATES (%) (CP-L 2103);
A-2-7 (0) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M145).

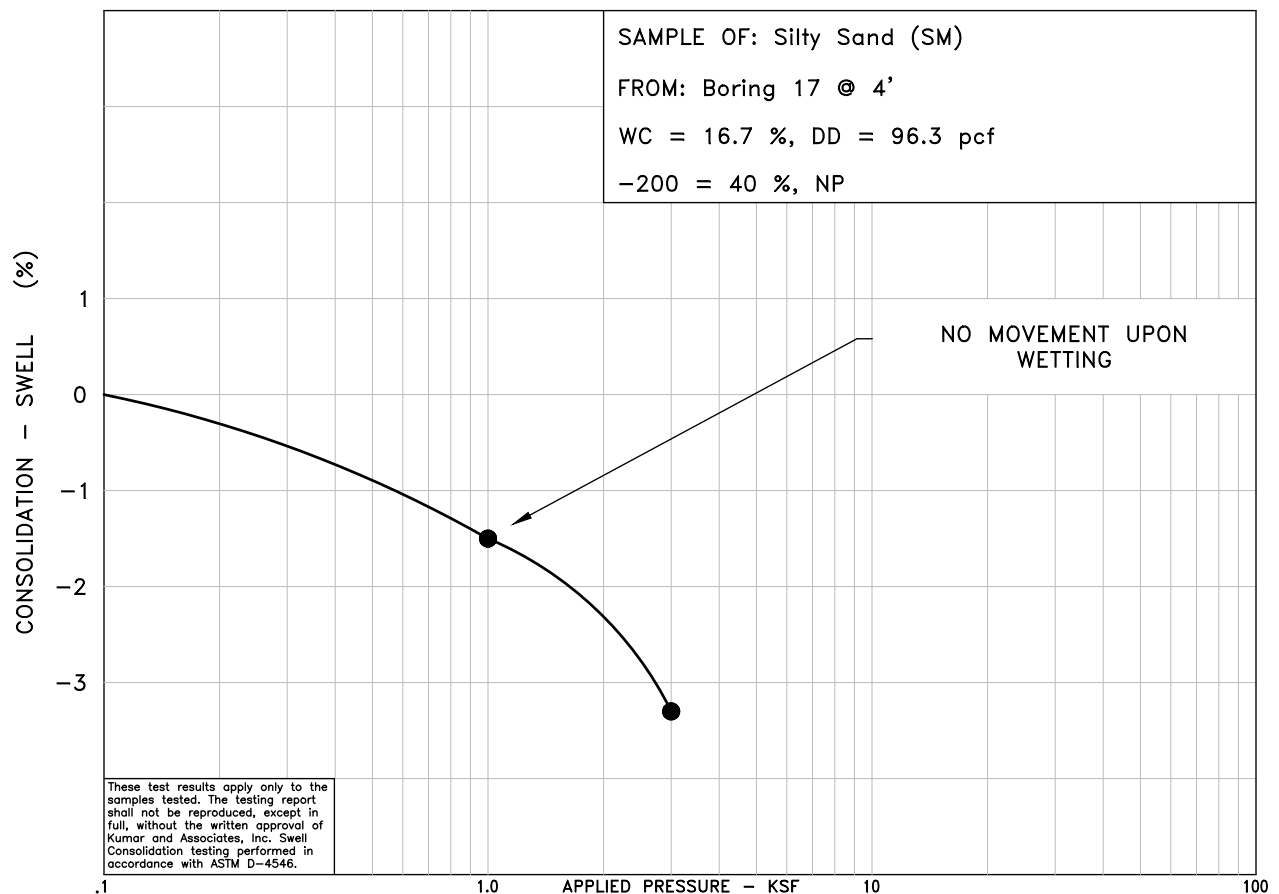
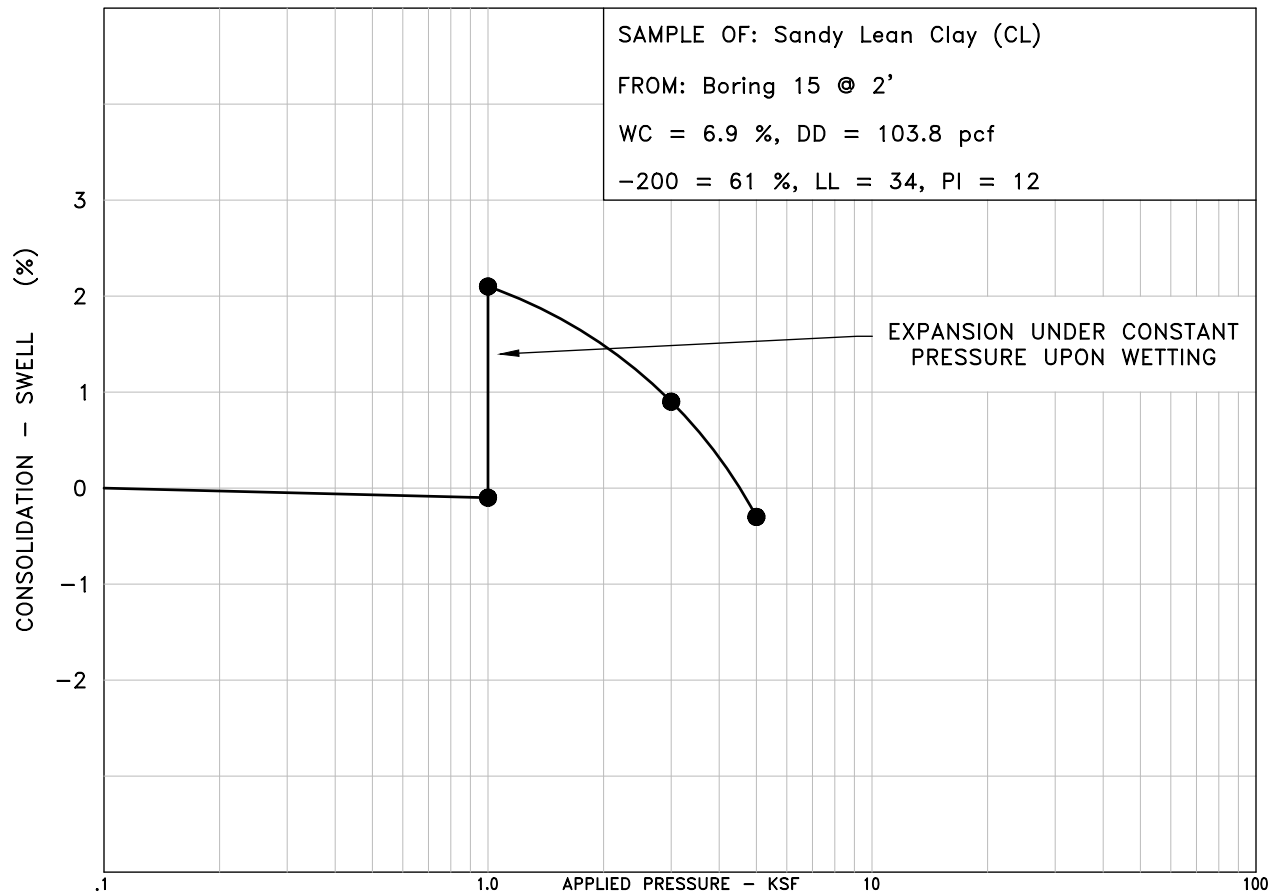


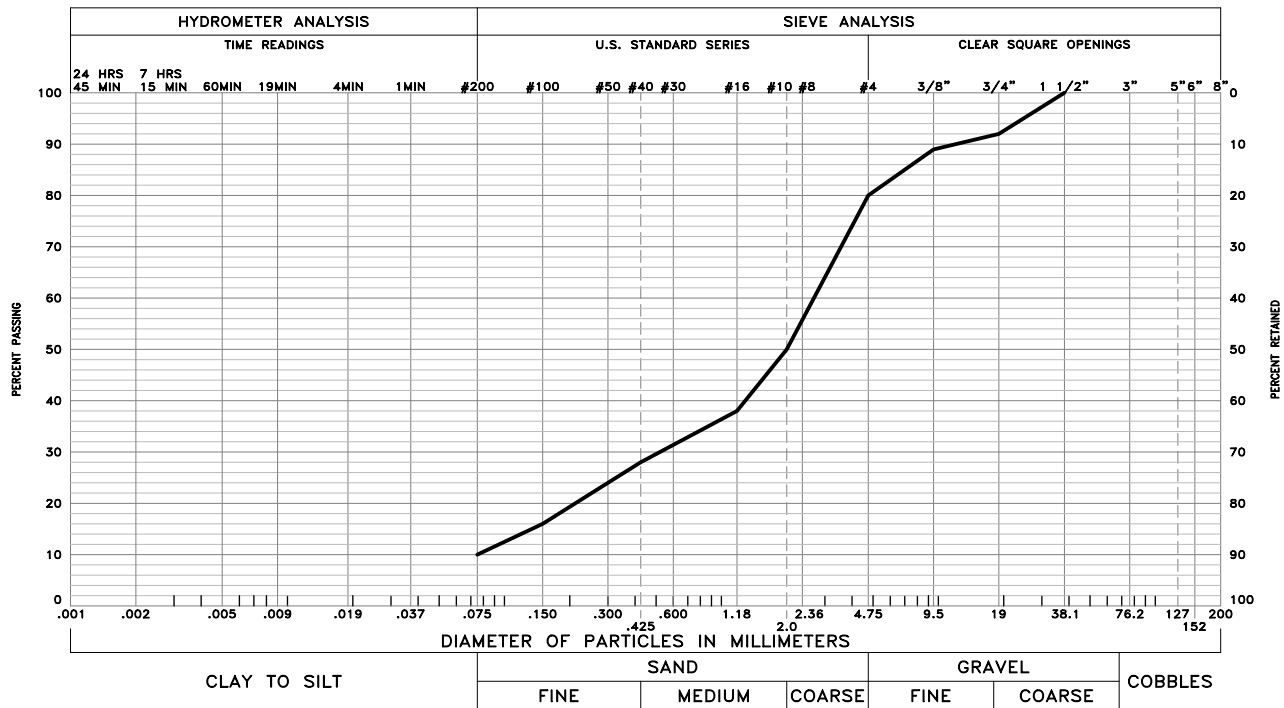






These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

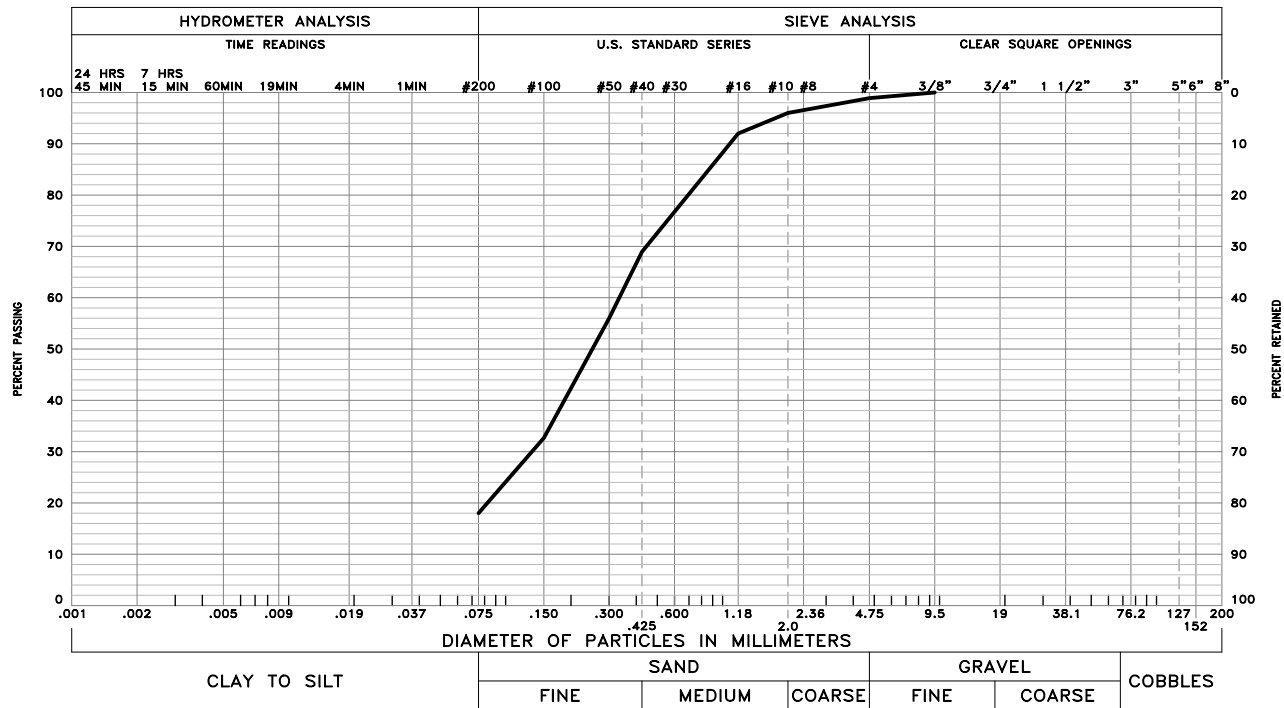




GRAVEL 20 % SAND 70 % SILT AND CLAY 10 %

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Fill: Well Graded Sand with Silt and Gravel (SW-SM) FROM: Boring 2 @ 2'

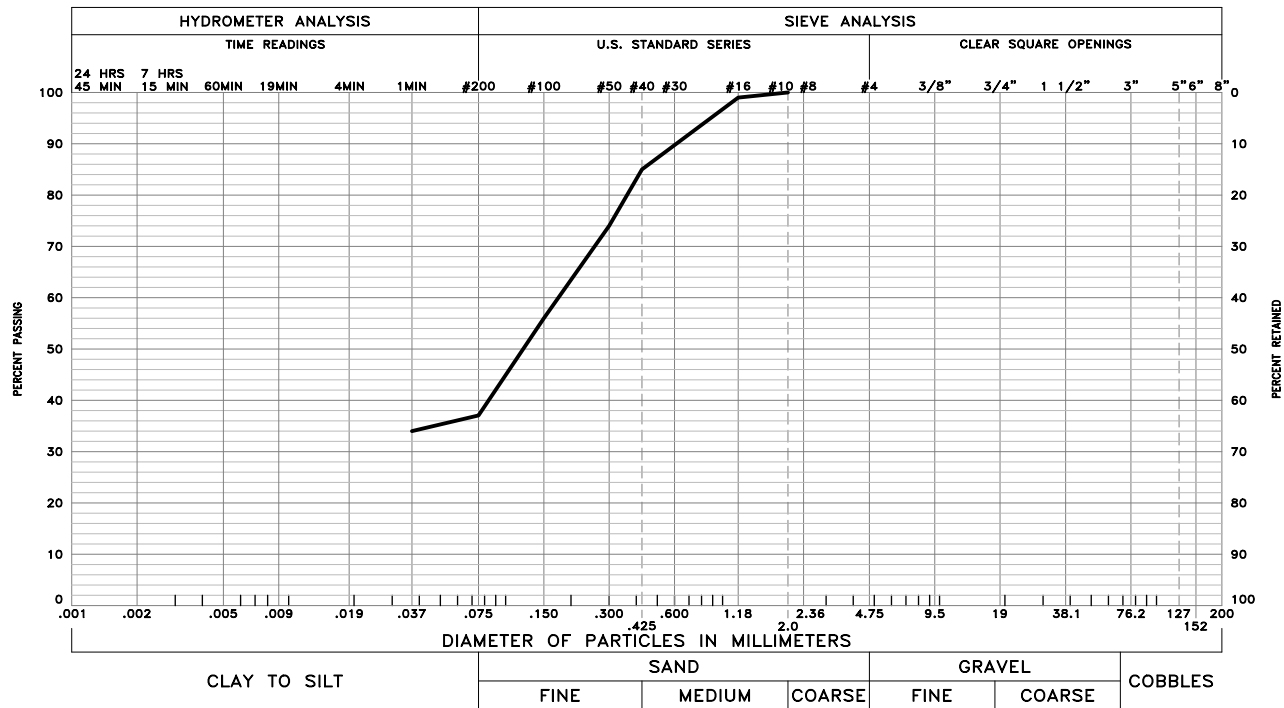
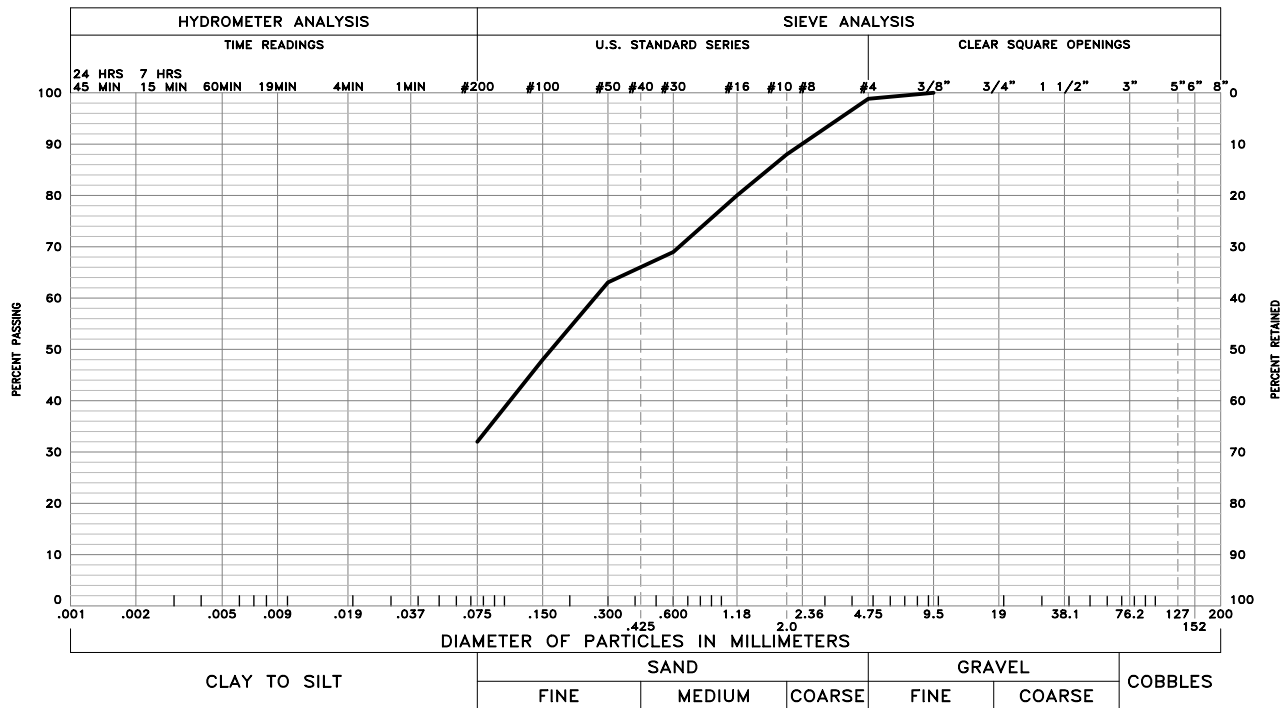


GRAVEL 1 % SAND 81 % SILT AND CLAY 18 %

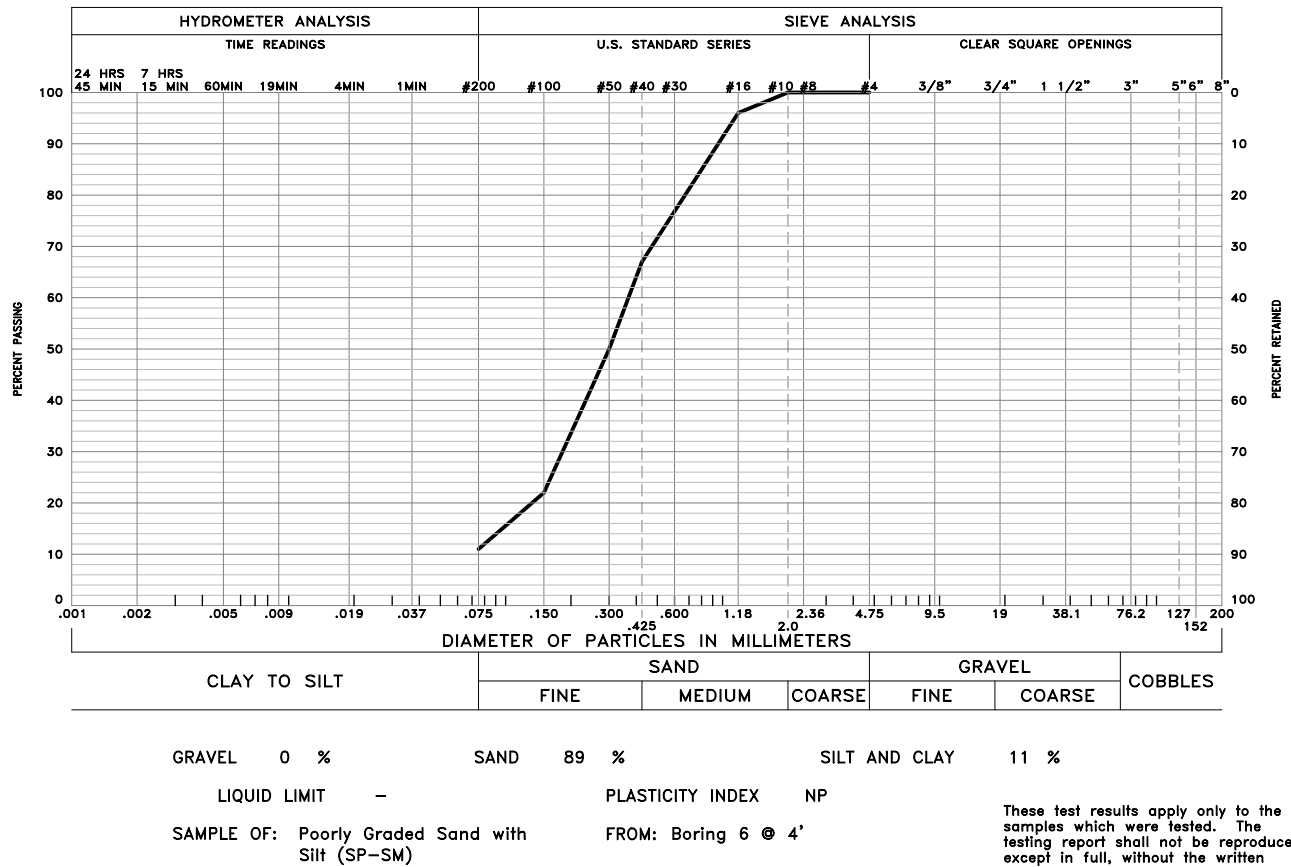
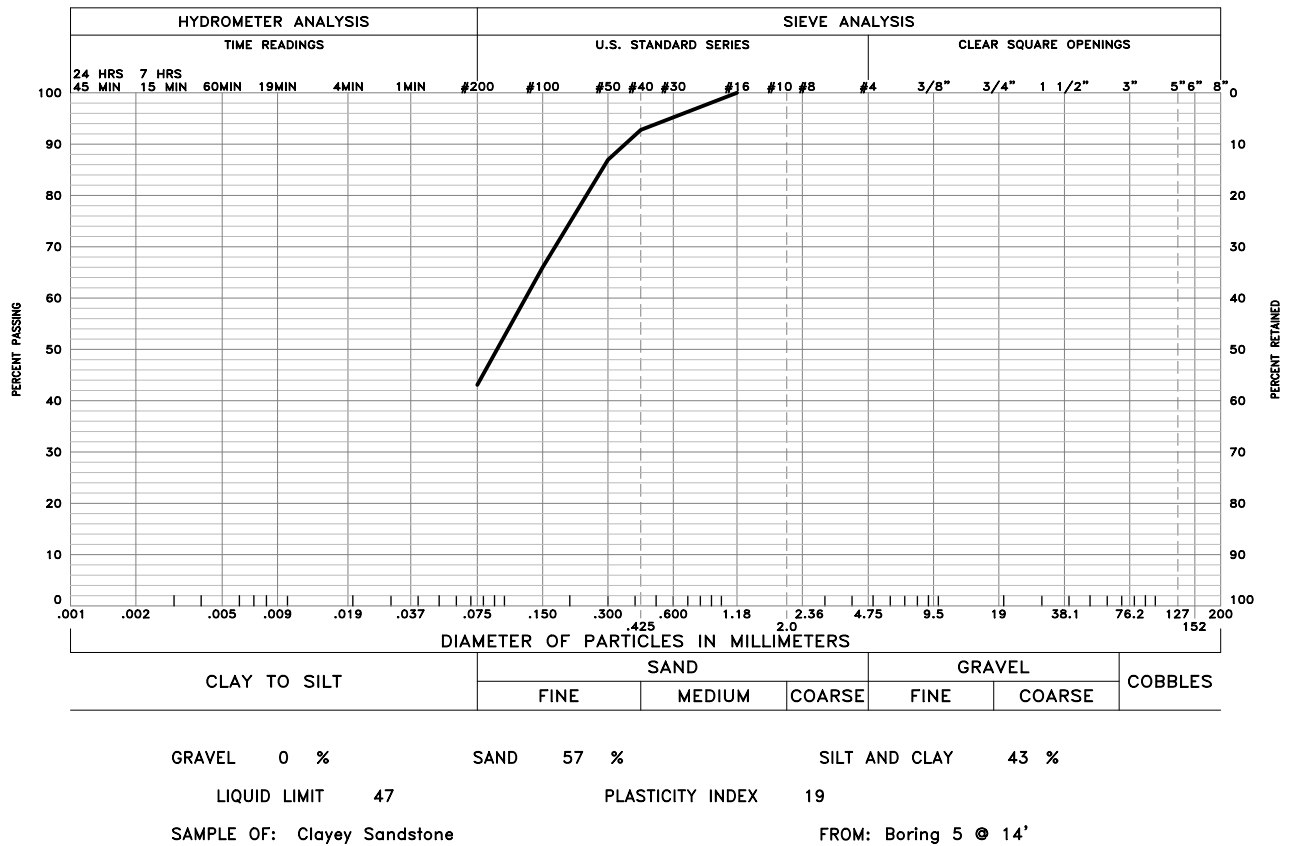
LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Fill: Silty Sand (SM) FROM: Boring 3 @ 4'

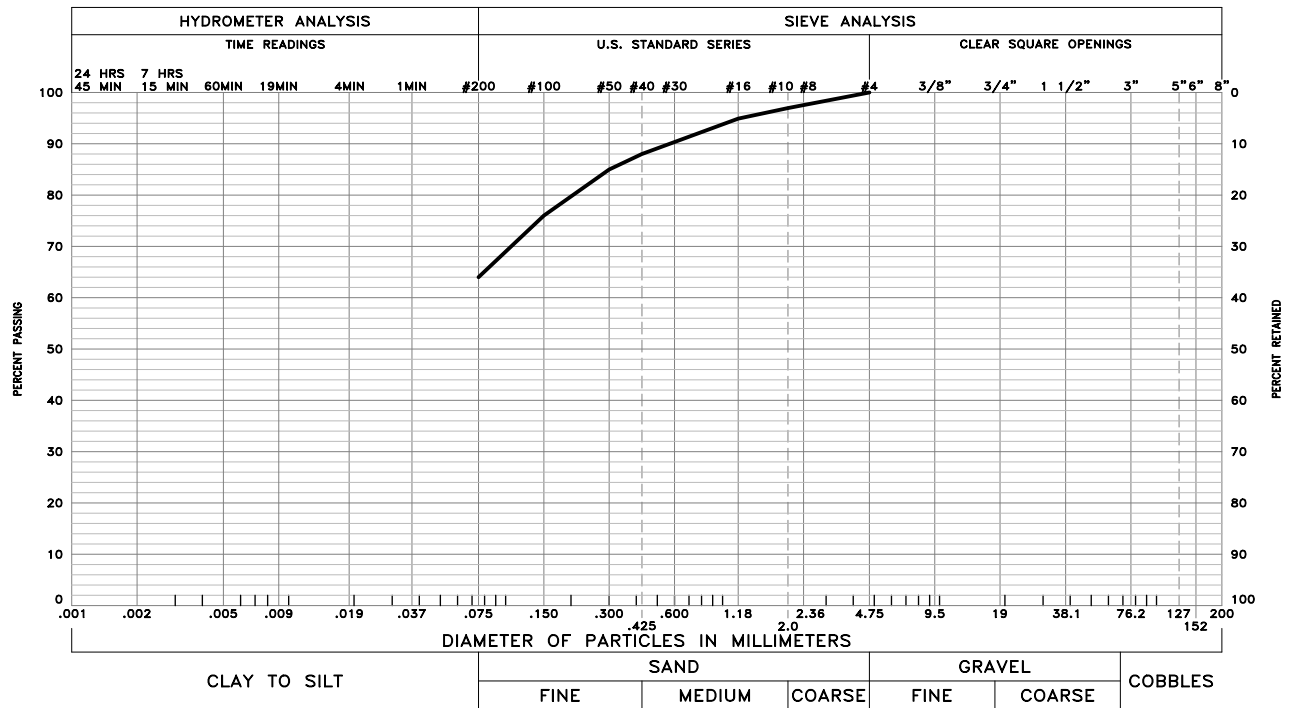
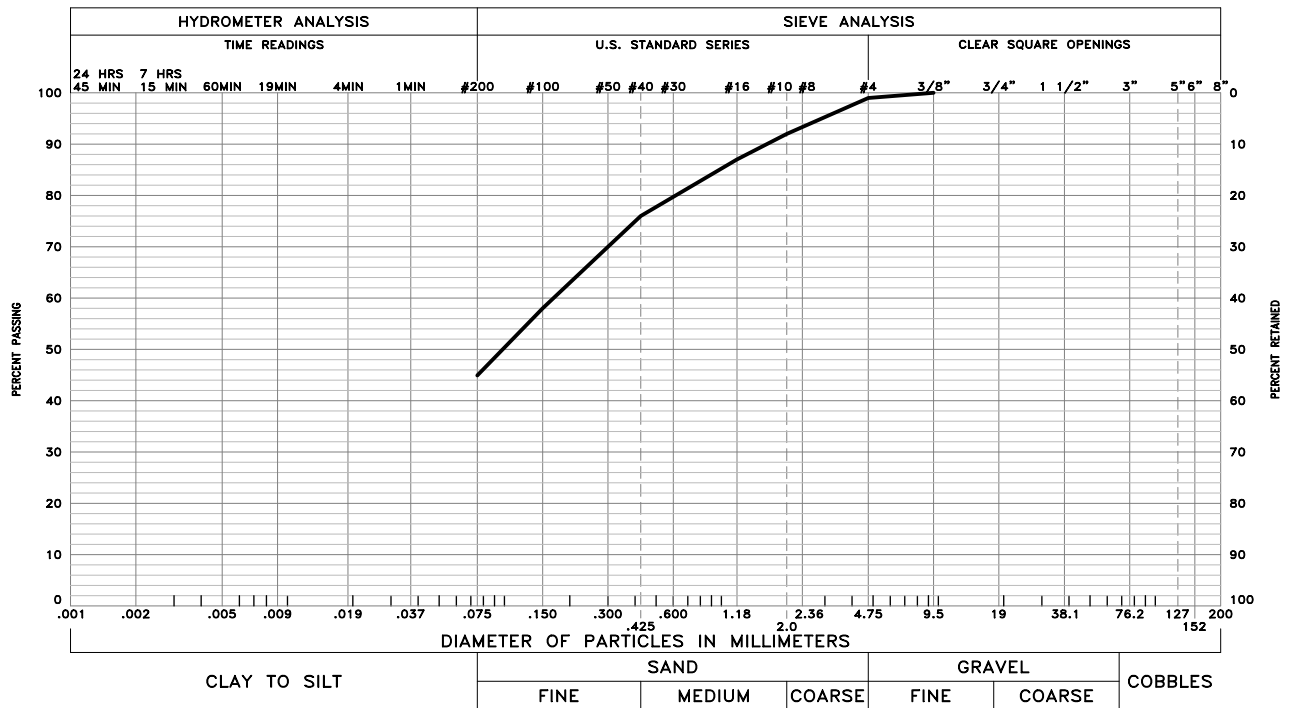
These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.



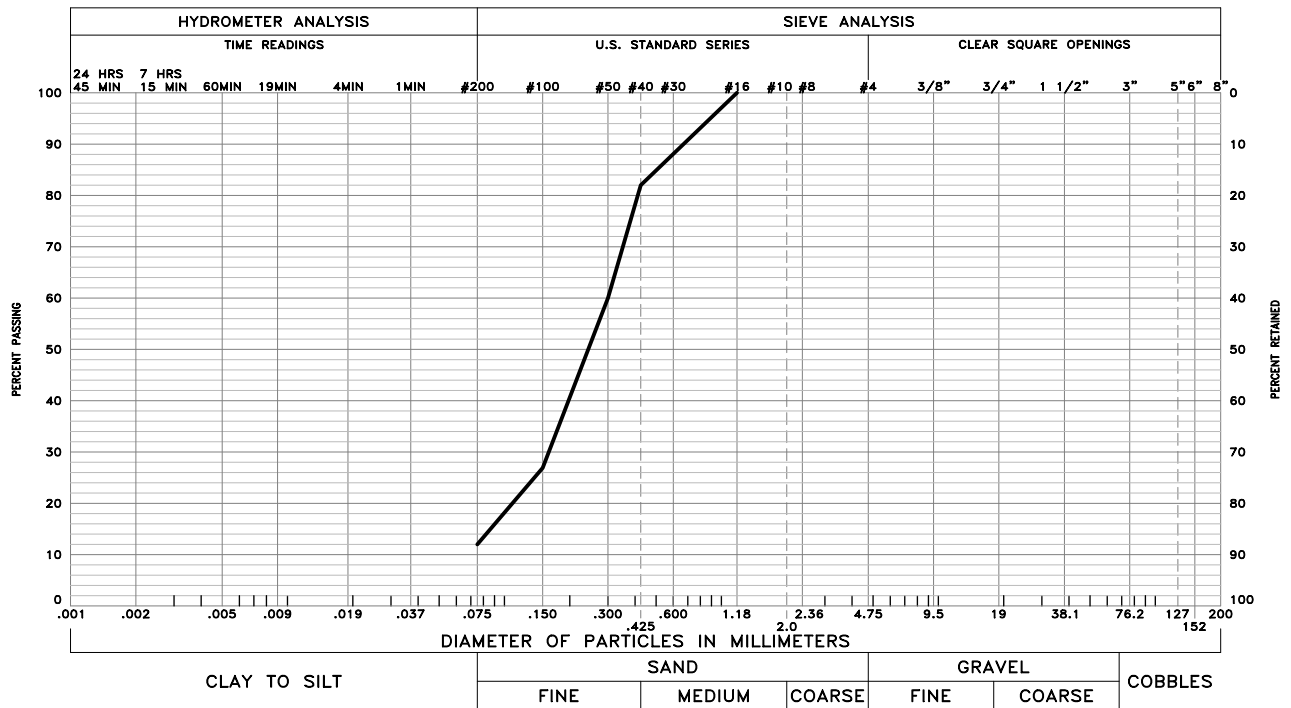
These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.



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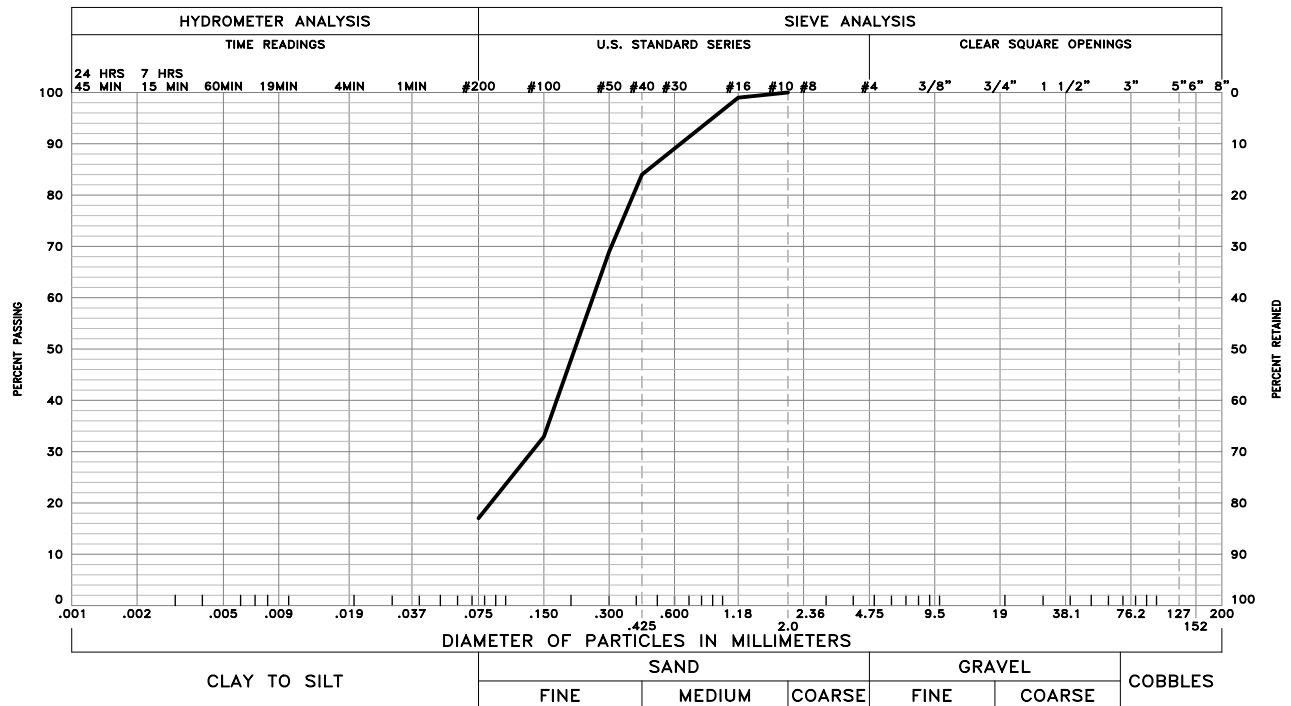
These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.



GRAVEL 0 % SAND 88 % SILT AND CLAY 12 %

LIQUID LIMIT - PLASTICITY INDEX NP

SAMPLE OF: Poorly Graded Sand with Silt (SP-SM) FROM: Boring 11 @ 9'

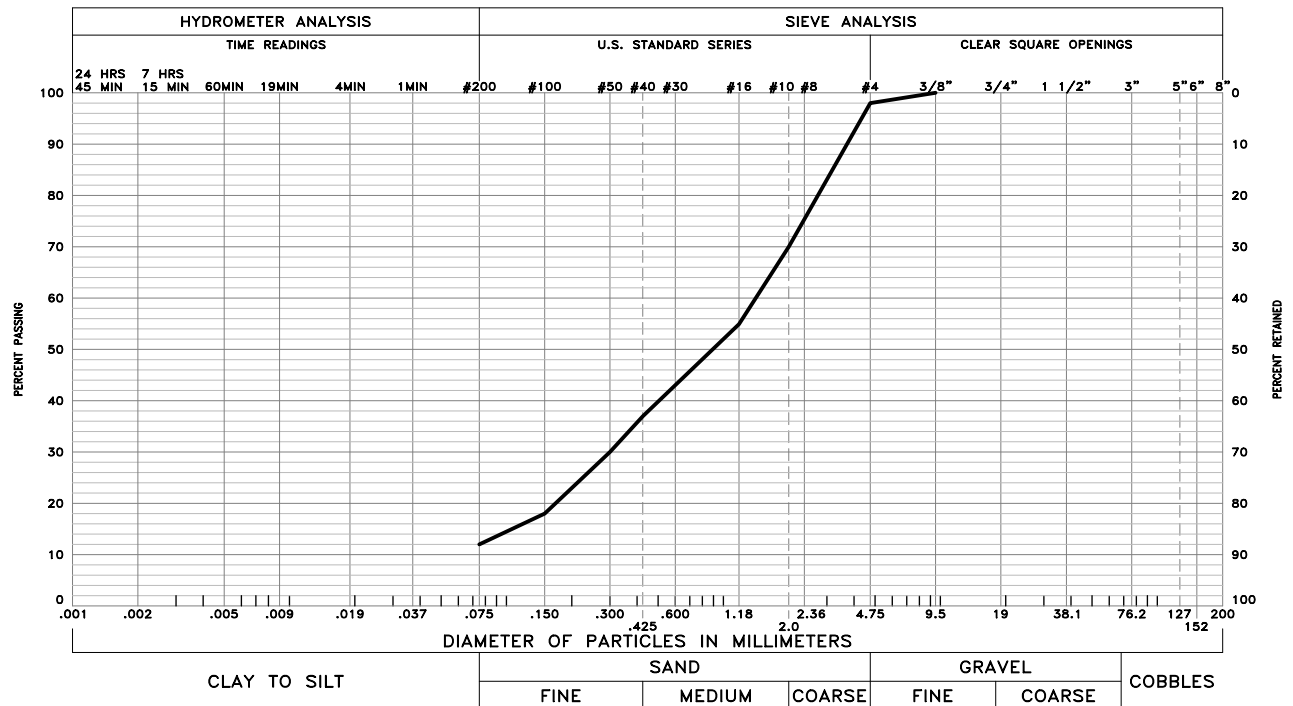


GRAVEL 0 % SAND 83 % SILT AND CLAY 17 %

LIQUID LIMIT 22 PLASTICITY INDEX 2

SAMPLE OF: Silty Sand (SM) FROM: Boring 13 @ 4'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.

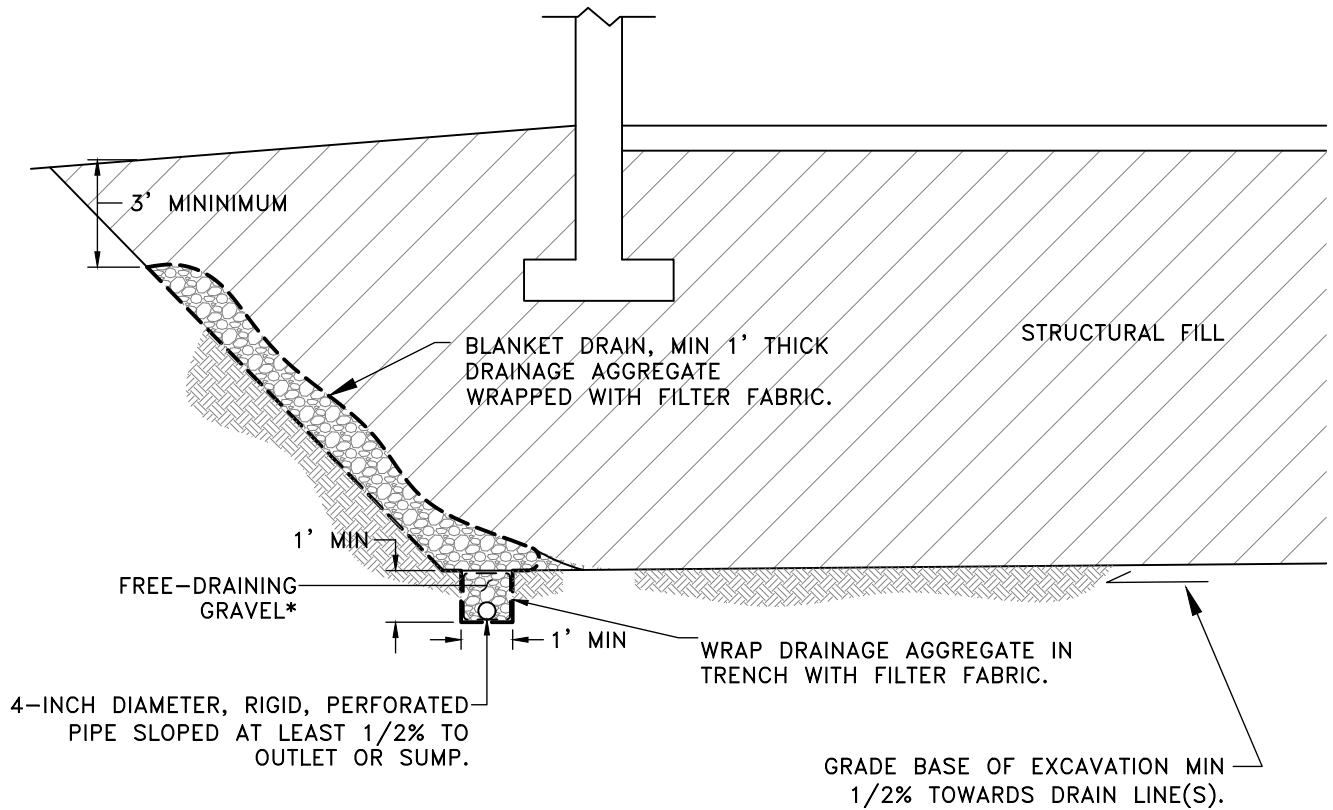


GRAVEL 2 % SAND 86 % SILT AND CLAY 12 %

LIQUID LIMIT - PLASTICITY INDEX NP

SAMPLE OF: Poorly Graded Sand with Silt (SP-SM) FROM: Boring 16 @ 9'

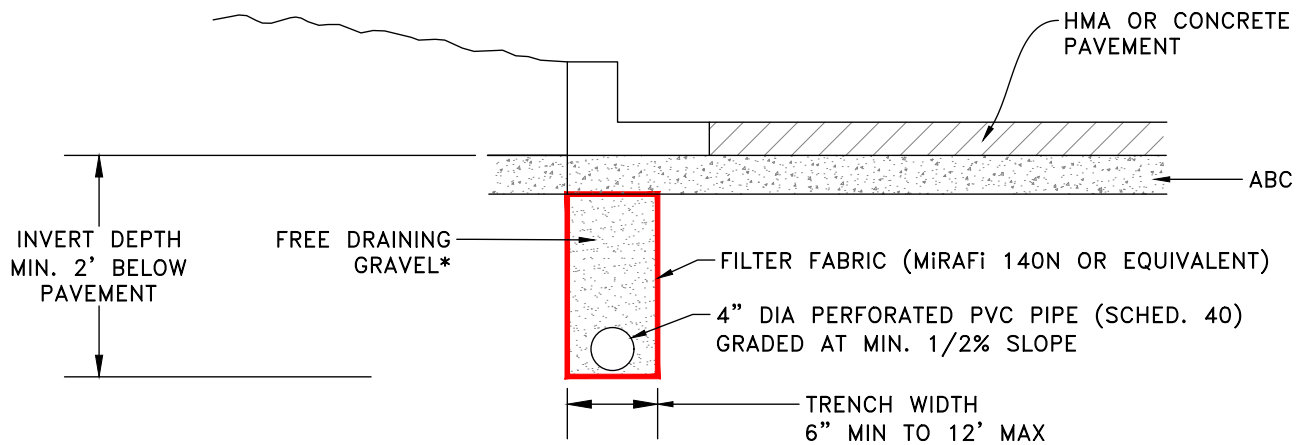
These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with ASTM D6913, ASTM D7928, ASTM C136 and/or ASTM D1140.



- * FREE-DRAINING GRAVEL SHOULD CONSIST OF A MINUS 2-INCH AGGREGATE WITH LESS THAN 30% PASSING THE NO. 4 SIEVE AND LESS THEN 5% PASSING THE NO. 200 SIEVE. FILTER FABRIC SHOULD CONSIST OF MIRAFI 140N OR EQUIVALENT.

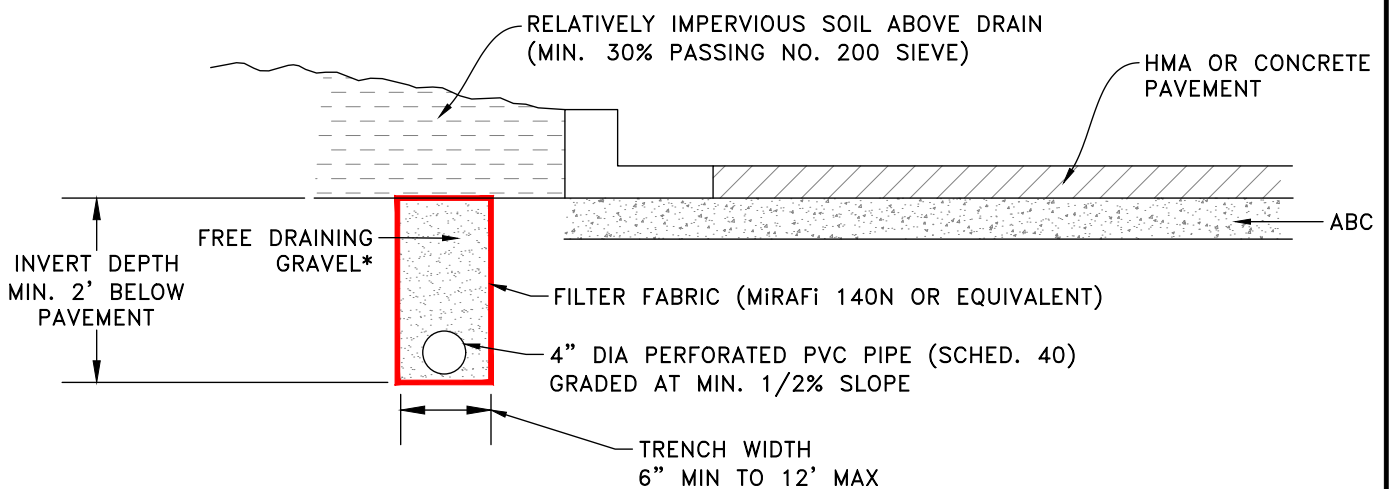
NOT TO SCALE

IF BELOW PAVEMENT:



* [MAX 2"
MAX 30% PASSING NO. 4
MAX 5% PASSING NO. 200]

IF ADJACENT TO PAVEMENT:



* [MAX 2"
MAX 30% PASSING NO. 4
MAX 5% PASSING NO. 200]

NOT TO SCALE

Kumar and Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 20-2-234.A

Project Name: AFW Update

Date Sampled: 11/16/2020 and 8/1/2024 / 8/2/2024

Date Received: 11/17/2020 and 8/2/2024

Page 1 of 3

[illegible]

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Date Received: 11/17/2020 and 8/2/2024

Page 2 of 3

[illegible]

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

Page 3 of 3

[illegible]

APPENDIX



Kumar & Associates, Inc.
Geotechnical and Materials Engineers
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GEOTECHNICAL ENGINEERING STUDY
PROPOSED AMERICAN FURNITURE WAREHOUSE
PROPOSED TUTT BOULEVARD
SOUTH OF WOODMEN ROAD
COLORADO SPRINGS, COLORADO

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SUMMARY

1. The subsoils encountered in the borings generally consisted of silty sand, with less frequently occurring lean to fat clay and clayey sand. The native soils extended to depths ranging from approximately 1 to 25 feet in the borings drilled within the building footprint. In the remaining borings, the native soils were encountered to approximate depths of 8.5 feet and 19.5 feet in two borings and to the maximum 5- to 20-foot depth explored in seven borings. The overburden soils are underlain by sandstone and/or claystone bedrock, which extended to the maximum 10- to 45-foot depths explored.
2. When measurements were made between four and eight days after drilling, ground water was encountered in 13 of the 23 borings at depths ranging from approximately 12 to 30 feet. Ground water was encountered in 11 of the 14 borings drilled within the building footprint. In one of these borings, the ground-water level was measured approximately 2 feet above the proposed finished floor elevation.
3. We recommend the proposed building be founded with spread footings bearing on a minimum 3-foot-thick layer of nonexpansive structural fill. At a minimum, we also recommend the native clay soils and claystone bedrock, present within 8 feet below the proposed foundation bearing elevation, be overexcavated and replaced with nonexpansive structural fill. Footings placed on the structural fill should be designed for an allowable soil bearing pressure of 2,000 psf.
4. Floor slabs should be supported on the on-site native granular soils and/or on a layer of nonexpansive structural fill. Clay soils and claystone bedrock present within 6 feet of the proposed floor slab elevation should be overexcavated and replaced with nonexpansive structural fill.
5. The majority of the subgrade soils in the parking lot south of the building and the anticipated borrow soils from the area east of the site consist of granular A-4 soils. Pavement sections are provided in the report assuming the subgrade soils will be granular, and have an AASHTO classification of A-4 or better. This will require that all fill placed within 2 feet of pavement subgrade elevation consist of A-4 soils and that clays and claystone present within 2 feet of pavement subgrade elevation be overexcavated and replaced with A-4 soils. Alternate pavement sections are provided that assume the clay soils and claystone are left in place.

PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical engineering study for the proposed American Furniture Warehouse to be located between the proposed Tutt Boulevard to the east and Powers Boulevard to the west and south of Woodmen Road, in Colorado Springs, Colorado. The subsurface study was conducted for the purpose of providing recommendations for foundations, floor slabs and pavements. The project site is shown on Figure 1. The study was conducted in general accordance with the scope of work in our proposal dated February 2, 2007.

Kumar & Associates previously prepared a preliminary geotechnical engineering report, dated November 30, 2006, for the site. Information from our previous report was utilized to develop recommendations contained herein.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to the proposed construction are included in the report.

PROPOSED CONSTRUCTION

We understand the proposed building will have approximate plan dimensions of 940X310 feet, and will be of precast-concrete and steel-frame construction. It is our understanding it is preferred to support the building with a spread-footing foundation system, and have a slab-on-grade floor. In the mezzanine area, maximum anticipated foundation loads are 450 kips for columns, and on the order of 15 kips per linear foot for walls. Maximum foundation loads in the warehouse area are anticipated to consist of 150 kips for columns and on the order of 10 kips per linear foot for walls. An asphalt parking lot is proposed south of the building; two access roads will be constructed to connect the parking area to the future Tutt Boulevard; and a fire lane road will be constructed around the building. Concrete pavement is planned in the loading dock area. A detention pond will be constructed west of the parking lot. Based on the grading plan provided, we understand maximum cuts and fills of approximately 24 feet and 14 feet, respectively, will be required within the building footprint.

Conceptual drawings provided indicate retaining walls will be constructed north, east and southeast of the building. The wall type(s) were not determined at the time our report was prepared. We understand the wall heights will range from approximately 4 to 30 feet north of the building, and approximately 7 to 19 feet east and southeast of the building.

If loadings, locations or conditions are significantly different from those described above or depicted in this report, we should be notified to reevaluate the recommendations contained herein.

SITE CONDITIONS

At the time of our field investigation, the site generally consisted of vacant land. The area of proposed development is bounded to the north by the closed Templeton Gap Landfill, to the south and east by vacant land, and to the west by Powers Boulevard. Templeton Gap Road is located nearby to the east. Future Tutt Boulevard trends north-south east of the site, and was asphalt paved from the north property boundary to the north. The portion of Tutt Boulevard that extends east of the property appeared to be rough graded. Topography on the subject site generally slopes gently to moderately to the west and southwest. There was approximately 40 feet of relief within the proposed building footprint. Two drainages occupy the site: one originates northeast of the property and flows south then west towards the western boundary of the site, the second drainage enters the site east of the northwest corner of the property then merges with the westerly flowing drainage. Vegetation on the majority of the site consists of grasses, weeds, yucca and cactus.

SUBSURFACE CONDITIONS

Information on the subsurface conditions was obtained by drilling 13 borings at the approximate locations shown on Figure 1. Eight borings were drilled within the building footprint, two borings were drilled in the detention pond area, and three borings were drilled in potential borrow areas east of the property. The ten borings previously drilled for the preliminary study are also included in this report. The boring logs are presented on Figures 2 through 5. Results of the laboratory testing program from borings drilled for this study are shown on Figures 2 through 11, and are summarized on Table I. Laboratory test results from the preliminary study are included in the appendix. The laboratory testing was conducted in general accordance with applicable ASTM standards. The following subsurface descriptions are of a generalized nature to highlight the major stratification features encountered in the borings drilled both for the preliminary study and for this study. The boring logs should be referenced for more detailed information.

Man-placed fill consisting of silty to clayey sand with vegetation material was encountered in one boring in the detention pond area to an approximate depth of 4 feet. Sampler penetration blow counts suggest the fill is noncompact. This study did not determine the exact lateral or vertical extent of the fill.

The native subsoils encountered in the borings generally consisted of silty sand, with less frequently occurring lean to fat clay and clayey sand. The native soils extended to depths ranging from approximately 1 to 25 feet in the borings drilled within the building footprint. In the remaining borings, the native soils were encountered to approximate depths of 8.5 feet and 19.5 feet in two borings and to the maximum 5- to 20-foot depth explored in seven borings. Sampler penetration blow counts indicate the silty sand and poorly graded sand with silt is very loose to very dense, the clayey sand is medium stiff to stiff, and the lean to fat clay is medium stiff to hard. Results of swell-consolidation tests presented on Figures 8, 9, 10 and in the appendix indicate the tested sample of lean clay was moderately compressible, the sample of silty clay had a moderate swell potential, and the samples of fat clay had a moderate to high swell potential when samples were wetted under a constant 1-ksf load.

The overburden soils are generally underlain by sandstone and/or claystone bedrock which was encountered to the maximum 10- to 45-foot depths explored. A contour map depicting the approximate bedrock surface is presented on Figure 12. Sampler penetration blow counts indicate the bedrock is firm to very hard. The upper approximate 3 to 4 feet of the claystone was weathered in three of the borings. Results of swell-consolidation tests presented on Figures 8 through 11 and in the appendix indicate the tested samples of claystone ranged from having a low to high swell potential when wetted under a constant 1-ksf load.

When measurements were made between four and eight days after drilling, ground water was encountered in 13 of the 23 borings at depths ranging from approximately 12 to 30 feet. Ground water was also encountered in nine of these borings at the time of drilling. Ground water was encountered in 11 of the 14 borings drilled within the building footprint. In one of these borings, the ground-water level was measured approximately 2 feet above the proposed finished floor elevation. Fluctuations in the water level may occur with time.

FOUNDATION RECOMMENDATIONS

Native clay soils and claystone bedrock with a moderate to high swell potential were encountered near the proposed foundation bearing elevation in the exploratory borings drilled in the eastern portions of the building footprint. Shallow foundations placed directly on or near expansive materials similar to that encountered at this site can experience movement causing structural distress if the materials are subjected to changes in moisture content.

Straight-shaft piers drilled into the bedrock are usually the preferred foundation system for this condition; however, piers are considered impractical at this site because of the great depth to bedrock, on the order of 30 feet below the proposed slab level, in the western portion of the building. Therefore we recommend the building be founded on spread footings bearing on a layer of nonexpansive structural fill.

The design and construction criteria presented below should be observed for a spread footing foundation system. The construction details should be considered when preparing project documents.

1. In order to provide relatively uniform support, we recommend the foundations bear on a minimum 3-foot-thick layer of nonexpansive structural fill. At a minimum, we also recommend the native clay soils and claystone bedrock, present within 8 feet below the proposed foundation bearing elevation, be overexcavated and replaced with nonexpansive structural fill. The structural fill layer is intended to provide separation between the expansive materials and thereby reduce the potential for foundation movement. Increasing the thickness of this structural fill layer will further reduce the potential for foundation uplift. The limits of areas requiring overexcavation should be defined by additional exploration at the time of grading.
2. Footings placed on the nonexpansive structural fill should be designed for an allowable soil bearing pressure of 2,000 psf.
3. The specifications for structural fill materials and compaction are presented in the "Site Grading" section of the report.
4. New fill should extend down from the edges of the footings at a minimum 1/2 horizontal to 1 vertical projection.
5. We estimate total movement for footings designed and constructed as discussed in this section will not exceed 1 inch. We anticipate the majority of foundation settlement will occur during construction.

6. It has been our experience that unusual loading conditions can occur with precast panel construction founded on a spread footing foundation system such as continuous or strip footings, due to practices used in erecting the heavy concrete panels. The method of panel placement can greatly influence the actual loading conditions on the footing during construction. A common practice is to support the panels with narrow shim stacks placed near the outside ends of each panel. This results in a concentrated load condition at each shim stack. The load on the footing is actually compounded by placement of shim stacks on adjoining panels, resulting in point loading of the foundation at ends of panels. Depending on the panel size and support details, the actual point load can greatly exceed the allowable bearing pressure and can result in localized, non-uniform settlement resulting in undesirable movement at the joints between panels. This condition can be aggravated if the foundation subgrade is allowed to be wetted from water ponding adjacent to footings, which can result in unacceptable panel settlement.

The panel erection contractor should be made aware of the potential for accelerated or non-uniform movement and measures should be taken to reduce the potential for such movement to occur. Measures that can be considered include placement of more shim stacks between the panel and footing and placement of the dry pack mortar prior to releasing the entire load onto the footing.

7. Spread footings should have a minimum width of 16 inches for continuous footings and 24 inches for isolated pads.
8. Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 30 inches below the exterior grade is typically used in this area.
9. The lateral resistance of a spread footing placed on properly compacted fill material will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the

bottoms of the footings may be calculated based on an allowable coefficient of friction of 0.3. Passive pressure against the sides of the footings may be calculated using an allowable equivalent fluid unit weight of 180 pcf. Compacted fill placed against the sides of the footings to resist lateral loads should be a nonexpansive granular material compacted to at least 95% of the maximum standard Proctor density within two percent of the optimum moisture content.

10. Continuous foundation walls should be reinforced top and bottom to span an unsupported length of at least 12 feet.
11. Areas of loose material encountered within the foundation excavation should be removed and replaced with properly compact structural fill.
12. Granular foundation soils should be compacted with a smooth vibratory compactor prior to placement of concrete.
13. The base of the structural fill layer appears to be below the water level in the eastern portion of the building footprint. Therefore, it may be necessary to dewater some of the excavation during construction.
14. A representative of the geotechnical engineer should observe all footing excavations prior to fill and concrete placement.

SEISMIC DESIGN CRITERIA

Using estimated shear wave velocities for the subgrade materials encountered, and assuming approximately 30 feet of granular overburden soil underlain by claystone and sandstone bedrock, calculations indicate a design Site Class C per the 2003 International Building Code (IBC).

FLOOR SLABS

Floor slabs present a difficult problem where moderately to highly expansive materials are present near floor slab elevation because sufficient dead load cannot be imposed on them to resist the uplift pressure generated when the materials are wetted and expand. The most

positive method to avoid damage as a result of floor slab movement is to construct a structural floor above a well-ventilated crawl space. Based on the moisture-volume change characteristics of the materials encountered, we believe slab-on-ground construction may be used, provided the risk of distress resulting from slab movement is recognized and accepted by the owner and the following measures are taken to reduce the damage which could result from movement should the underslab materials be subjected to moisture changes.

1. Floor slabs should be supported on the on-site native granular soils and/or on a layer of nonexpansive structural fill. Clay soils and claystone bedrock present within 6 feet of the proposed floor slab elevation should be overexcavated and replaced with nonexpansive structural fill. Increasing the thickness of the structural fill layer will further reduce the potential for slab movement.
2. The specifications for structural fill materials and compaction are presented in the "Site Grading" section of the report.
3. Floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement.
4. Interior nonbearing partitions resting on floor slabs should be provided with slip joints so that, if the slabs move, the movement cannot be transmitted to the upper structure. This detail is also important for wallboards, stairways and doorframes. Slip joints, which will allow at least 2 inches of vertical movement, are recommended.

If wood or metal stud partition walls are used, the slip joints should be placed at the bottoms of the walls so differential slab movement will not damage the partition wall. If slab bearing masonry block partitions are constructed, the slip joints will have to be placed at the tops of the walls. If slip joints are provided at the tops of walls and the floors move, it is likely the partition walls will show signs of distress, such as cracking. An alternative, if masonry block walls or other walls without slip joints at the bottoms are required, is to found them on footings and to construct the slabs independently of the foundation. If slab bearing partition walls are required, distress may be reduced by connecting the partition walls to the exterior walls using slip channels.

Floor slabs should not extend beneath exterior doors or over foundation grade beams, unless saw cut at the beam after construction.

5. Floor slab control joints should be used to reduce damage due to shrinkage cracking. Joint spacing is dependent on slab thickness, concrete aggregate size and slump, and should be consistent with recognized guidelines such as those of the Portland Cement Association (PCA) or American Concrete Institute (ACI). The joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use.
6. If moisture-sensitive floor coverings will be used, mitigation of moisture penetration into the slabs, such as by use of a vapor barrier, may be required. If an impervious vapor barrier membrane is used, special precautions will be required to reduce the potential for differential curing problems which could cause the slabs to warp. Section 302.1R of the ACI Manual of Concrete Practice addresses this topic.
7. All plumbing lines should be tested before operation. Where plumbing lines enter through the floor, a positive bond break should be provided. Flexible connections should be provided for slab-bearing mechanical equipment.

The precautions and recommendations itemized above will not prevent the movement of floor slabs if the underlying expansive materials are subjected to alternate wetting and drying cycles. However, the precautions should reduce the damage if such movement occurs.

LOADING DOCK WALLS

Earth retaining loading dock walls which will be laterally supported and can be expected to undergo only a moderate amount of deflection should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of 55 pcf for backfill consisting of the on-site granular soils. The loading dock walls should be designed for appropriate surcharge pressures using a lateral earth pressure coefficient of 0.45.

Backfill should be placed in uniform lifts and compacted to 95% of the maximum standard Proctor density within two percent of the optimum moisture content. Care should be taken not to overcompact the backfill since this could cause excessive lateral pressure on the walls.

SITE RETAINING WALLS

Design recommendations for site retaining walls are not provided in this report because the wall type and heights have not been finalized. We should be consulted to provide specific recommendations for the site retaining walls after the wall type, height and alignments have been finalized. If cantilevered cast-in-place concrete walls are used, we anticipate overexcavation of the expansive clay soil and claystone bedrock will be required where it is encountered within approximately 4 to 6 feet below the footing grades. Drilled piers would also be a feasible foundation system for support of cantilevered retaining walls.

Mechanically stabilized earth (MSE) block retaining walls would have the advantage in that they are less sensitive to movements and may not require overexcavation of the expansive materials. The required length of reinforcement behind MSE walls is typically on the order of 70% of the wall height. Therefore, MSE walls are not generally used where walls are retaining in cuts because of the large volume of excavation required behind the walls. MSE walls are usually best suited for fill areas because the reinforced zone of the MSE wall can be constructed in conjunction with the fill. Another disadvantage to MSE type walls is that the length of reinforcement limits how close the walls can be constructed to property boundaries.

WATER SOLUBLE SULFATES

The concentration of water-soluble sulfates measured in samples obtained from the exploratory borings were approximately 0.03% or less. These concentrations of water-soluble sulfates represent a negligible degree of sulfate attack on concrete exposed to these materials.

The degree of attack is based on a range of negligible, positive, severe and very severe as presented in the U.S. Bureau of Reclamation Concrete Manual. However, based on the subsurface conditions encountered and our experience in the area, we anticipate the on-site soils and bedrock to have sufficient concentrations of water soluble sulfates to cause sulfate attack on concrete exposed to these materials. Therefore, we recommend all concrete exposed to the on-site materials contain ASTM C 150 Type II cement or an appropriate blended cement intended for moderate sulfate resistance in accordance with ASTM C 595. Concrete should

have a minimum cement content of 564 pounds (6 sacks) per cubic yard, have a maximum water-cement ratio (by weight) of 0.45, and have air entrainment.

SUBSURFACE DRAINS

Building Underdrain: Portions of the overexcavation zone will extend below the ground-water level. In addition, the overexcavation recommended usually creates a localized “bathtub” in which water may collect and cause the highly expansive bedrock to swell and cause distress. We therefore recommend the perimeter of the eastern portion of the building requiring overexcavation of bedrock below foundations be protected by an underdrain system. The underdrain system should consist of 4-inch diameter perforated Schedule 40 PVC pipe, surrounded by a minimum of 1 foot of free-draining gravel, around the perimeter of the bottom of the excavation. To collect seepage of permeable zones within bedrock, the underdrain system should also include a blanket drain along the face of the excavated cut slopes where bedrock is encountered. The blanket drain should consist of a 1-foot-thick layer of free draining gravel wrapped with filter fabric and hydraulically connected to the perimeter drain. The blanket drain should extend up to within 3 feet of the pavement grade. Geocomposite drainage board may be used in lieu of the blanket drain. Relatively impervious fill should be used above the blanket drain to reduce migration of surface water into underdrain.

Schedule 40 PVC pipe is recommended, as flexible pipes can be easily crushed during construction operations and are hard to detect. We also recommend installing occasional cleanouts to enable future inspections of the drain lines. The drain line should be sloped at a minimum ½ % slope to positive outlets where water can be removed by pumping or gravity flow. The underdrain line and gravel should be wrapped with suitable filter geotextile such as Mirafi Filterweave 402 or equivalent. Free-draining gravel should consist of maximum 1 ½ inch size aggregate with less than 30% passing the No. 4 sieve and less than 5% passing the No. 200 sieve.

Pavement Edge Drain: The water levels measured indicate ground water will be near or slightly above the pavement grade. This water can saturate the materials under the pavement, causing them to lose strength and result in pavement failure. The shallow ground water at the site may contribute to pavement distress. Because of this, we recommend a subsurface interceptor drain be installed along the upslope side of the north and east sides of the building

adjacent to the pavement areas where claystone and/or sandstone bedrock is present at depths of 2 feet or less from the proposed pavement subgrade. The drain is intended to reduce the amount of subsurface water which enters the material beneath the pavement surface. If the retaining wall designs include a drain that extends to a minimum 2 feet below the pavement subgrade, a pavement edge drain would not be necessary.

The drains should be installed so they are 2 feet below the pavement subgrade. The drains should consist of a minimum 4-inch-diameter perforated PVC pipe placed in the bottom of a trench and surrounded above the invert level with free-draining gravel. The free-draining gravel should extend up to the bottom of the curb and gutter or base of pavement and should be surrounded with filter fabric. The drains should be sloped to a gravity outlet. If the drain is not located below the pavement, the backfill above the gravel should consist of a relatively impervious soil. Once wall details become available, a pavement drain detail can be provided upon request.

SURFACE DRAINAGE

Proper surface drainage is very important for acceptable performance of the building during construction and after the construction has been completed. The following recommendations should be used as guidelines and changes should be made only after consultation with the geotechnical engineer.

1. Excessive wetting or drying of the foundation and slab subgrades should be avoided during construction.
2. Exterior backfill should be adjusted to within two percent of the optimum moisture content and compacted to at least 95% of the standard Proctor maximum dry density.
3. Care should be taken when compacting around foundation walls and underground structures to avoid damage to the structure.
4. The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 6 inches in the first 10 feet in unpaved areas. Site drainage beyond the 10-foot zone

should be designed to promote runoff and reduce water infiltration. A minimum slope of 3 inches in the first 10 feet is recommended in the paved areas. These slopes may be changed as required for handicap access points in accordance with the Americans with Disabilities Act.

5. Ponding of water should not be allowed in backfill material or within 20 feet of the foundation walls, whichever is greater.
6. Roof downspouts and drains should discharge well beyond the limits of all backfill.
7. Lawn sprinkler heads and landscaping which requires typical irrigation and should be located at least 10 feet from foundation walls. Irrigation schemes are available which allow placement of lightly irrigated landscape near foundation walls in moisture sensitive soil areas. Drip irrigation heads with main lines located at least 10 feet from the foundation walls are acceptable provided irrigation quantities are limited.
8. Plastic membranes should not be used to cover the ground surface adjacent to foundation walls. A pervious geotextile may be used to inhibit weed growth.

EXCAVATION CONSIDERATIONS

In our opinion, the near surface bedrock and overburden soils encountered in the exploratory borings drilled for this study can be excavated with heavy-duty construction equipment with rippers. It is possible that localized, harder lenses of bedrock may be encountered within the excavation in other areas. If harder rock is encountered, hydraulic chiseling may be required, particularly in confined trench excavations.

All excavations should be in accordance with OSHA, state and local requirements. The contractor should follow appropriate safety precautions. In accordance with OSHA guidelines, the silty sand overburden soils above the ground-water level classify as a Type C material, and the clayey sand, clay and bedrock classifies as Type B. Temporary unretained excavations in Type C materials should have slopes no steeper than 1 ½:1 (H:V) and Type B materials should have slopes no steeper than 1:1, unless shored. Flatter slopes will be required where ground-water seepage is encountered. We anticipate slopes of 2:1 to 3:1 will be required in these

areas. OSHA regulations require that excavations greater than 20 feet in depth be designed by a professional engineer.

Based on the conditions encountered in the exploratory borings, it appears excavations for the building will extend on the order of 8 to 11 feet below the ground-water level measured at the time of our study. It appears most excavations below the ground-water level will extend into bedrock. For this condition, we anticipate dewatering can be accomplished using a system of trenches and sumps around the perimeter of the base of the excavation. The trenches should be sloped to the sumps where water can be pumped from the excavation. If it is necessary to dewater granular soils in excavations above the bedrock, methods that lower the ground-water level below the base of the excavation should be used to avoid loss of supporting capacity of the soils. Depending on the depth of overexcavation below the ground-water level, the use of methods such as well points or cutoff drains may be feasible. The contractor may have other methods for accomplishing dewatering. We can provide our input into those methods upon request.

SITE GRADING

Cut and Fill Slopes: We recommend the following criteria be used when preparing site grading plans. Permanent cut and fill slopes should not be steeper than 3:1 (horizontal to vertical) and should not exceed 30 feet in height. Slopes will generally be stable at 2:1; however, 2:1 slopes will be prone to increased surface erosion and it will be difficult to maintain vegetation on them. Cut and fill slopes of greater heights are feasible; however, they should be investigated on an individual basis. The risk of slope instability will be significantly increased if seepage is encountered in cuts. If seepage is encountered in permanent excavations, an investigation should be conducted to determine if the seepage will adversely affect the cut stability. Fills should be benched into hillsides steeper than 4:1.

Good surface drainage should be provided for all permanent cuts and fills to direct the surface runoff away from the slope faces. Cut and fill slopes and other stripped areas should be protected against erosion by revegetation or other means. Site grading should be planned to provide positive surface drainage away from all building and pavement areas.

No formal stability analyses were performed to evaluate the slopes recommended above. Published literature and our experience with similar cuts and fills indicate the recommended slopes should have adequate factors of safety. If a detailed stability analysis is required, we should be notified.

Fill Material Specifications: The following material specifications are presented for fills on the project site.

1. *Fill Beneath Building Foundations and Floor Slabs:* Structural fill placed for support of foundations and floor slabs should consist of a minus 2-inch nonexpansive relatively impervious soil having a minimum 25% passing the No. 200 sieve and a maximum plasticity index of 15. The tested samples indicate that most of the on-site materials, excluding fat clay and claystone meet these criteria.
2. *Pavement Areas:* Fill should consist of the on-site granular soils or similar imported soil which meets the minimum R-value used for the pavement design calculation. We recommend the claystone and clay soils not be used as fill within 2 feet below subgrade levels.
3. *Utility Trench Backfill:* Material excavated from the utility trenches may be used for backfill provided it does not contain unsuitable material or particles larger than 4 inches.
4. *Material Suitability:* All fill material should be free of vegetation, brush, sod and other deleterious substances and should not contain rocks or lumps having a diameter of more than 6 inches. The on-site claystone bedrock and fat clay will be expansive when placed in a compacted condition and is not suitable for use as nonexpansive fill. Fill should not contain concentrations of organic matter or other deleterious substances. The geotechnical engineer should evaluate the suitability of all proposed fill materials prior to placement.
5. *Existing Fill:* The existing fill encountered is not suitable for support of foundations, floor slabs or pavements, and should be removed in its entirety and replaced with properly compact structural fill prior to placement of concrete or fill.

Compaction Specifications: We recommend the following compaction criteria be used on the project:

1. Compaction of fill materials should be achieved within 2 percentage points of the optimum moisture content.
2. Fills should be compacted to the following minimum densities:

<u>Area</u>	<u>Percentage of Maximum Standard Proctor Density (ASTM D 698)</u>
Beneath Building	100%
Beneath Pavement Areas	95%
Landscape and Other Misc. Overlot Fill Areas	95%

3. A representative of the geotechnical engineer should observe fill placement operations on a full-time basis.

PAVEMENT DESIGN

Subgrade Materials: The existing subgrade soils encountered during our study classified as A-4, A-5, A-6, A-7-5 and A-7-6 with group indices ranging from 0 to 45 in accordance with the American Association of State Highway Transportation Officials (AASHTO) classification. The majority of the subgrade soils in the parking lot south of the building and the anticipated borrow soils from the area east of the site consist of granular A-4 soils. The majority of the soils that will be exposed in cuts around the east end of the building perimeter will be A-6 or A-7-6 soils, which have a lower strength than the A-4 soils. Based on the conditions encountered, we recommend the pavements be designed for an A-4 subgrade soil with an assumed R-value of 25. This will require that all fill placed within 2 feet of pavement subgrade elevation consist of A-4 soils and that clays and claystone present within 2 feet of pavement subgrade elevation be overexcavated and replaced with A-4 soils. As an alternative, the clay soils and claystone may be left in place if the pavements are designed for a reduced R-value of 5.

Design Traffic: Traffic loading information provided included the following 18-kip equivalent single axel load application (ESALs): 36,500 for the parking lot area, 73,000 for the fire lane, and 584,000 for the access drives and loading dock slab. If it is determined that actual traffic is significantly different, we should be contacted to reevaluate the pavement thickness design.

Pavement Sections: Recommended pavement sections were determined using the City of Colorado Springs Pavement Design Criteria Manual procedures. Based in the subgrade conditions encountered and the traffic information provided, we recommend the pavement sections listed in the following table.

Location	Design R-Value	Minimum Pavement Section Thickness (inches)	
		Full-Depth Asphalt	Composite Asphalt/Base Course
Parking Lot	25	5	3/6
	5	6	-
Fire Lane	25	5.5	4/6
	5	7	-
Access Drive Lanes	25	7.5	5/10
	5	9.5	-

We recommend that composite asphalt and base course pavement sections not be used in areas of clay or claystone subgrade because our experience indicates full-depth asphalt sections generally perform better on expansive subgrades than combined asphalt/aggregate base course sections. The use of aggregate base course provides a pervious layer above a relatively impervious subgrade. The base course can transmit water, causing changes in moisture content within the subgrade materials. Variations in the subgrade moisture content can be erratic and result in erratic volume changes which cause premature deterioration of the pavement. In addition, the thinner asphalt surface of a combined section can more easily allow water to penetrate through cracks and migrate through the aggregate base course. High moisture contents in the subgrade or base course will result in loss of strength.

We recommend the loading dock area and areas where truck turning movements are concentrated, such as at trash pickup areas, be paved with a minimum 7 inches of Portland cement concrete. This pavement section assumes a minimum of the upper 2 feet of the subgrade soils consists of materials with an AASHTO classification of A-4 or better. If the

clay or claystone subgrade is left in place immediately below the pavements, we recommend a minimum 8-inch section of Portland cement concrete.

Pavement Materials: The asphalt pavement should consist of a bituminous material which meets the requirements of the Pikes Peak Region Asphalt Paving Specifications. Aggregate base course should be a Class 5 or 6.

The concrete pavement should be based on a mix design established by a qualified engineer. Concrete should be air entrained with approximately 6% air and should have a minimum cement content of 6 sacks per cubic yard. Maximum allowable slump will depend on the method of placement but should not exceed 4 inches. The concrete should contain joints not greater than 15 feet on centers. The joints should be hand formed, sawed or formed by premolded filler. The joints should be at least 1/4 of the slab thickness. Expansion joints should be provided at the end of each construction sequence and between the concrete slab and adjacent structures. Expansion joints where required, should be filled with a ½-inch-thick asphalt impregnated fiber. Concrete should be cured by protecting against loss of moisture, rapid temperature changes and mechanical injury for at least three days after placement.

Subgrade Preparation: Prior to placing the pavement section, the entire subgrade area should be scarified to a minimum depth of 8 inches, adjusted to within two percentage points of the optimum moisture content, and compacted to a minimum 95% of the maximum standard Proctor density. The pavement subgrade should be proofrolled with a heavily loaded pneumatic-tired vehicle. Pavement design procedures assume a stable subgrade. Areas that deform under heavy wheel loads are not stable and should be removed and replaced to achieve a stable subgrade prior to paving.

Drainage: The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of the pavement. Drainage design should provide for the removal of water from paved areas and prevent the wetting of the subgrade soils. Recommendations for a pavement edge drain are included in the "Subsurface Drains" section of the report.

DESIGN AND CONSTRUCTION SUPPORT SERVICES

Kumar & Associates, Inc., should be retained to review the project plans and specifications for conformance with the recommendations provided in this report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project and, if necessary, perform additional studies to accommodate any changes in the proposed construction.

We recommend that Kumar & Associates, Inc., be retained to provide observation and testing services to document that the requirements of the plans and specifications are being followed during construction, and to identify possible variations in subsurface conditions from those encountered in this study.

LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for exclusive use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings at the locations indicated on Figure 1, and the proposed type of construction.

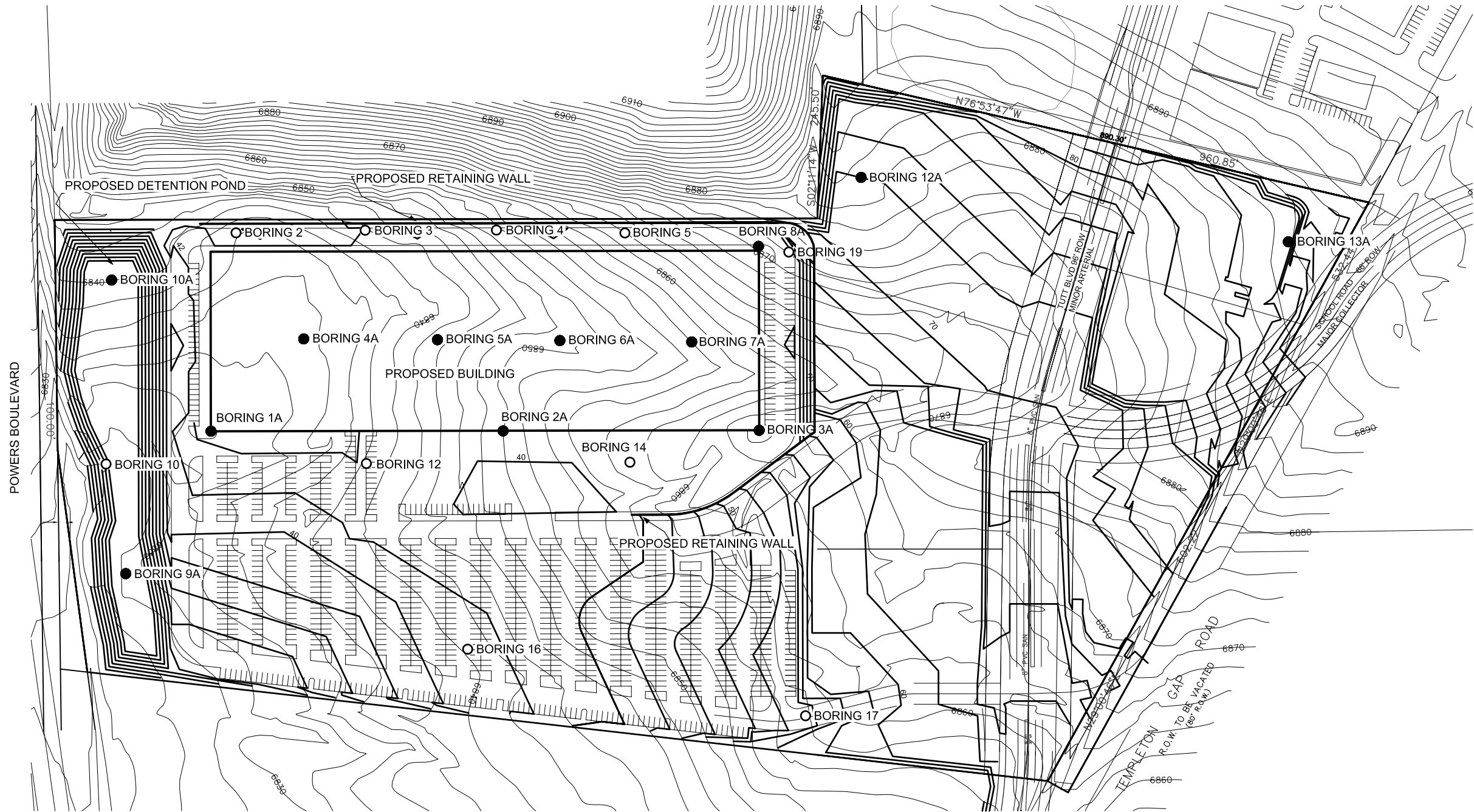
This report may not reflect subsurface variations that occur between the exploratory borings, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, rock or water conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

Swelling soils occur on this site. Such soils are stable at their natural moisture content but will undergo high volume changes with changes in moisture content. The extent and amount of perched water beneath the building site as a result of area irrigation and inadequate surface drainage is difficult, if not impossible, to foresee.

The recommendations presented in this report are based on current theories and experience of our engineers on the behavior of swelling soil in this area. The owner should be aware that there is a risk in constructing a building in an expansive soil area. Following the recommendations given by a geotechnical engineer, careful construction practice and prudent maintenance by the owner can, however, decrease the risk of foundation movement due to expansive soils.

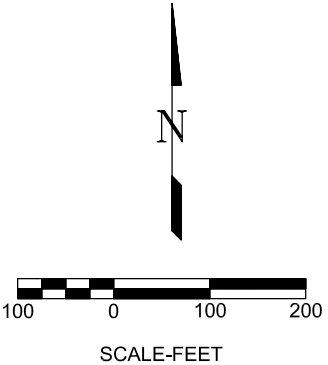
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Distribution: Client (5)

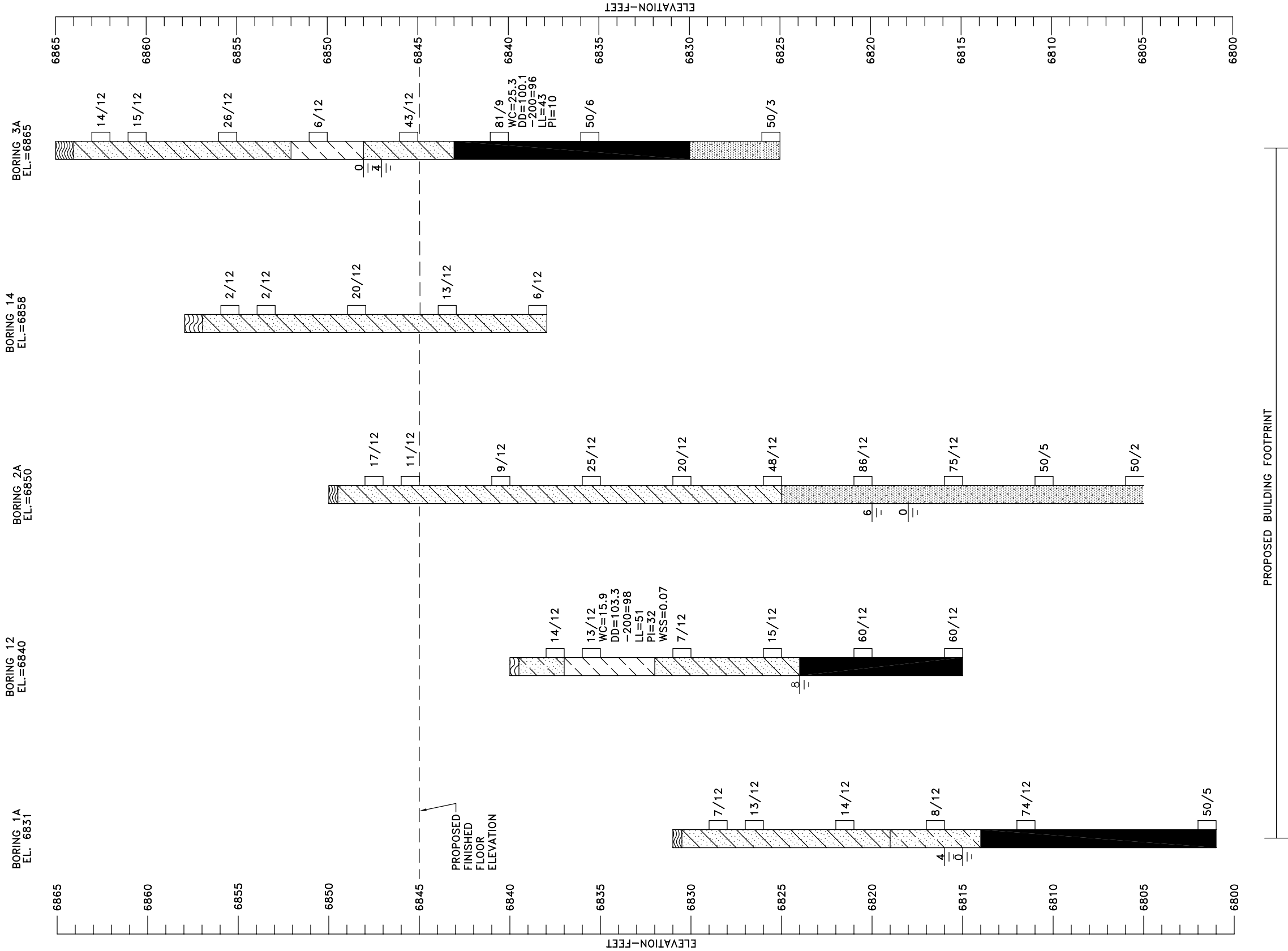


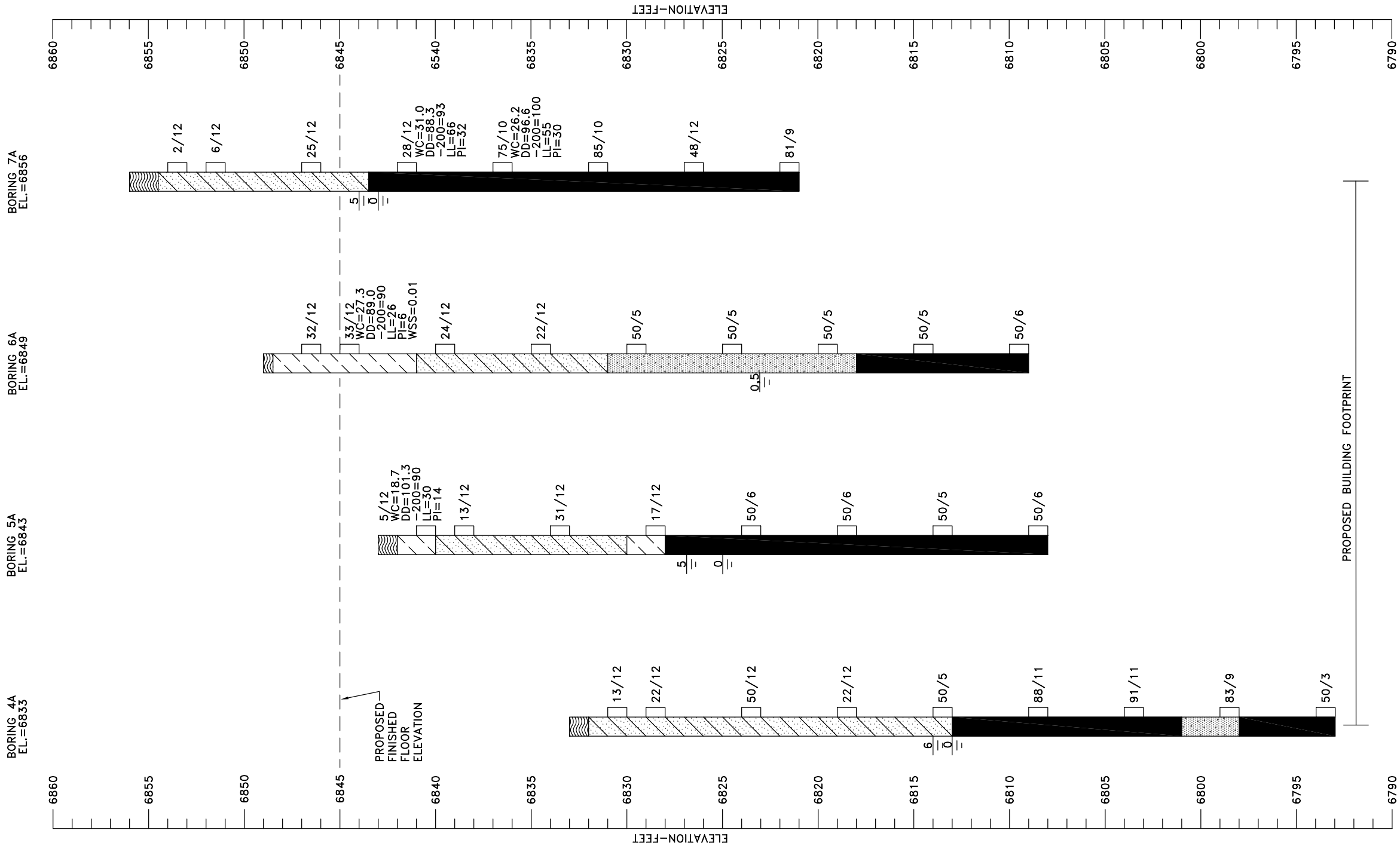
LEGEND

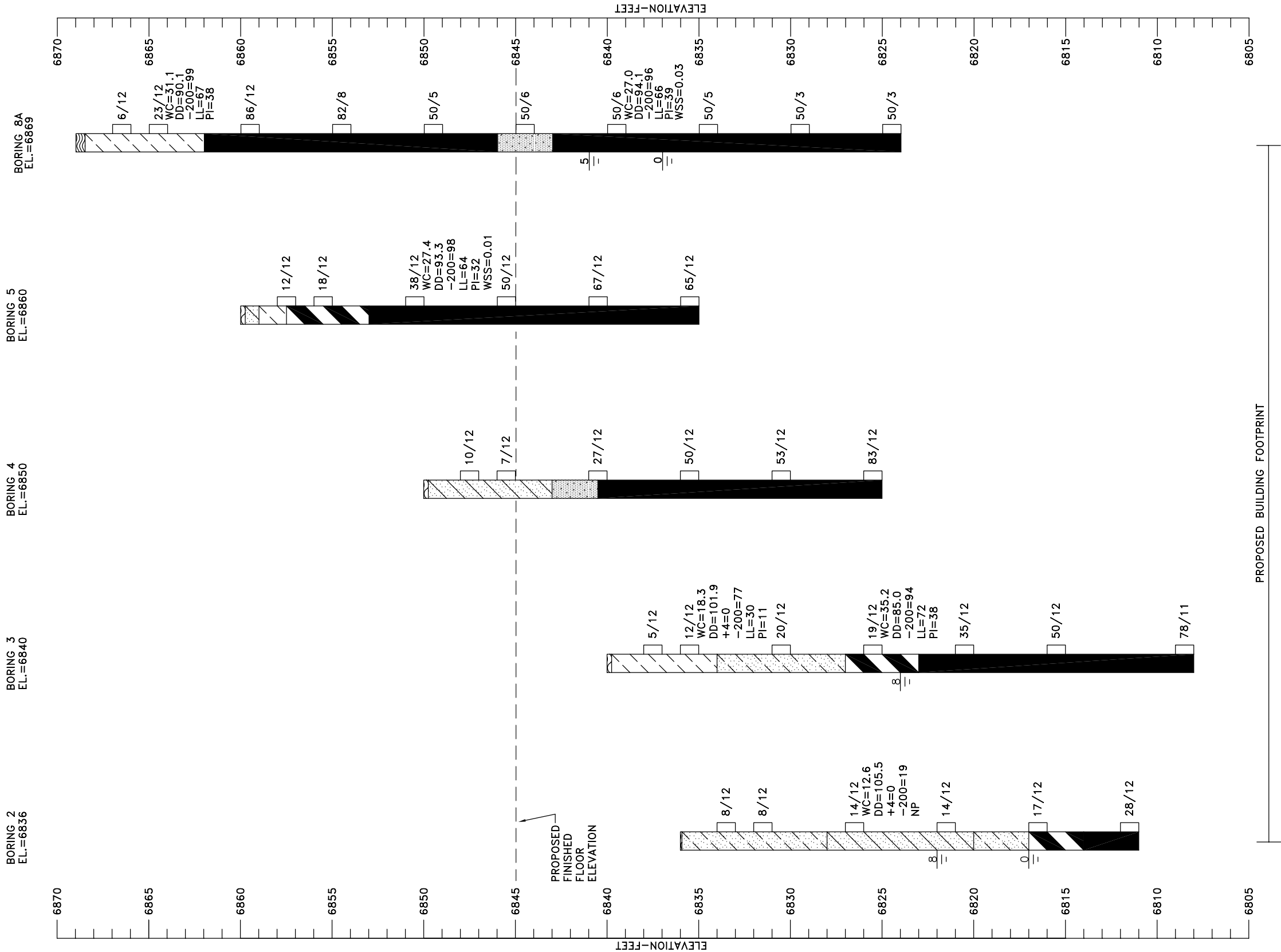
- BORINGS DRILLED FOR THIS STUDY.
- BORINGS DRILLED FOR PRELIMINARY GEOTECHNICAL ENGINEERING REPORT DATED NOVEMBER 30, 2006 (PROJECT NO. 062-259).



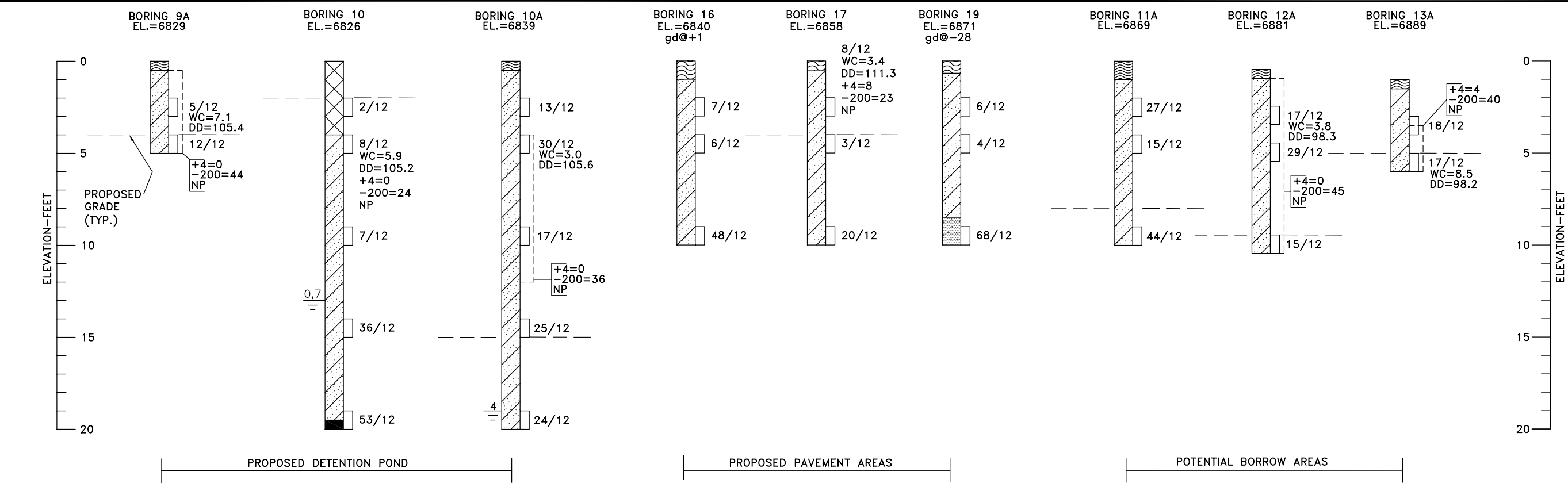
Mar 29, 07 - 13:09pm
C:\Drawing\2006\062259\062259.C\0112.dwg







Mar 29, 07Y - 13:21pm
C:\Drawings\2006\062259.C\062259.C-05.dwg



LEGEND

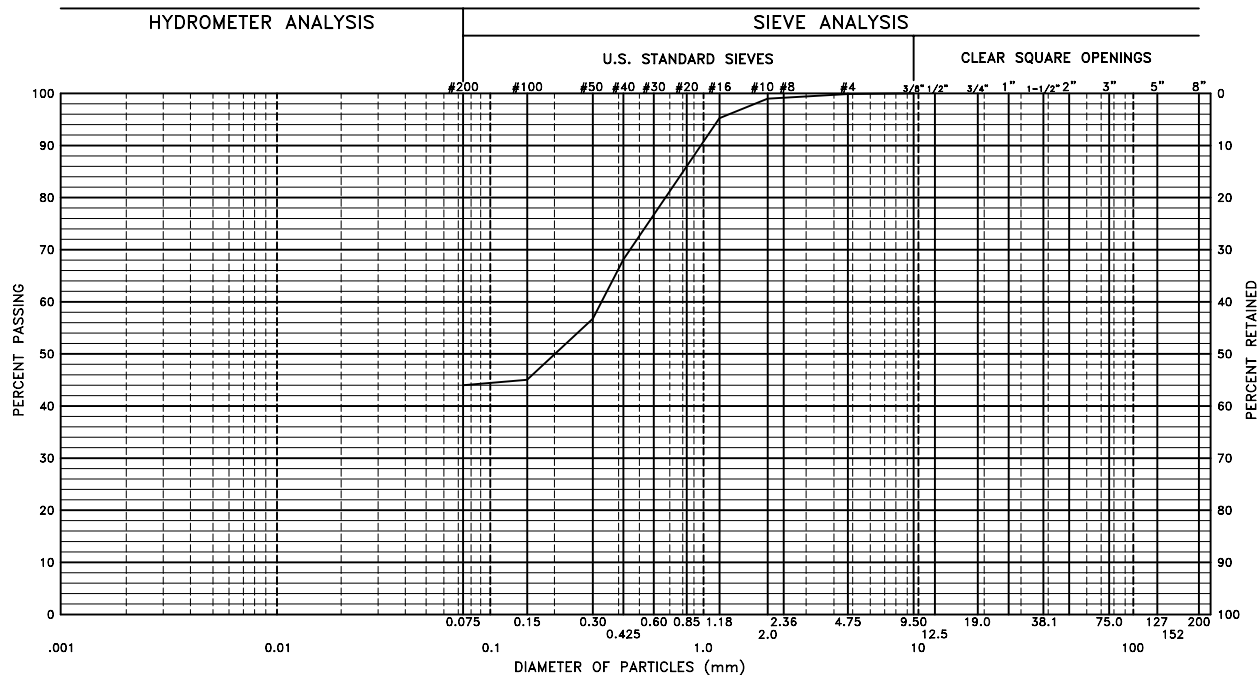
- TOPSOIL.
- FILL: SILTY TO CLAYEY SAND WITH VEGETATION MATERIAL, MOIST, DARK BROWN.
- SILTY SAND (SM), WITH LAYERS OF POORLY GRADED SAND WITH SILT (SP-SM), VERY LOOSE TO VERY DENSE, SLIGHTLY MOIST TO WET, LIGHT BROWN TO BROWN.
- CLAYEY SAND (SC), WITH OCCASIONAL LAYERS OF SANDY LEAN CLAY, MEDIUM STIFF TO STIFF, MOIST TO WET, BROWN.
- LEAN TO FAT CLAY (CL, CH), OCCASIONALLY SILTY AND SANDY, MEDIUM STIFF TO HARD, SLIGHTLY MOIST TO VERY MOIST, BROWN TO GRAYISH-BROWN.
- SANDSTONE BEDROCK, CLAYEY, FIRM TO VERY HARD, SLIGHTLY MOIST TO MOIST, BROWN TO OLIVE-BROWN.
- WEATHERED CLAYSTONE, STIFF TO VERY STIFF, SLIGHTLY MOIST TO MOIST, GRAYISH-BROWN TO OLIVE-BROWN.
- CLAYSTONE BEDROCK, FIRM TO VERY HARD, SLIGHTLY MOIST TO MOIST, GRAYISH-BROWN TO OLIVE-BROWN.
- DRIVE SAMPLE, 2-INCH I.D. CALIFORNIA LINER SAMPLE.
- 7/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 7 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.
- 4/- DEPTH TO WATER LEVEL AND NUMBER OF DAYS AFTER DRILLING MEASUREMENT WAS MADE.
- gd@+1 INDICATES PROPOSED GRADE IS APPROXIMATELY 1 FOOT ABOVE BORING ELEVATION.

LABORATORY TEST RESULTS

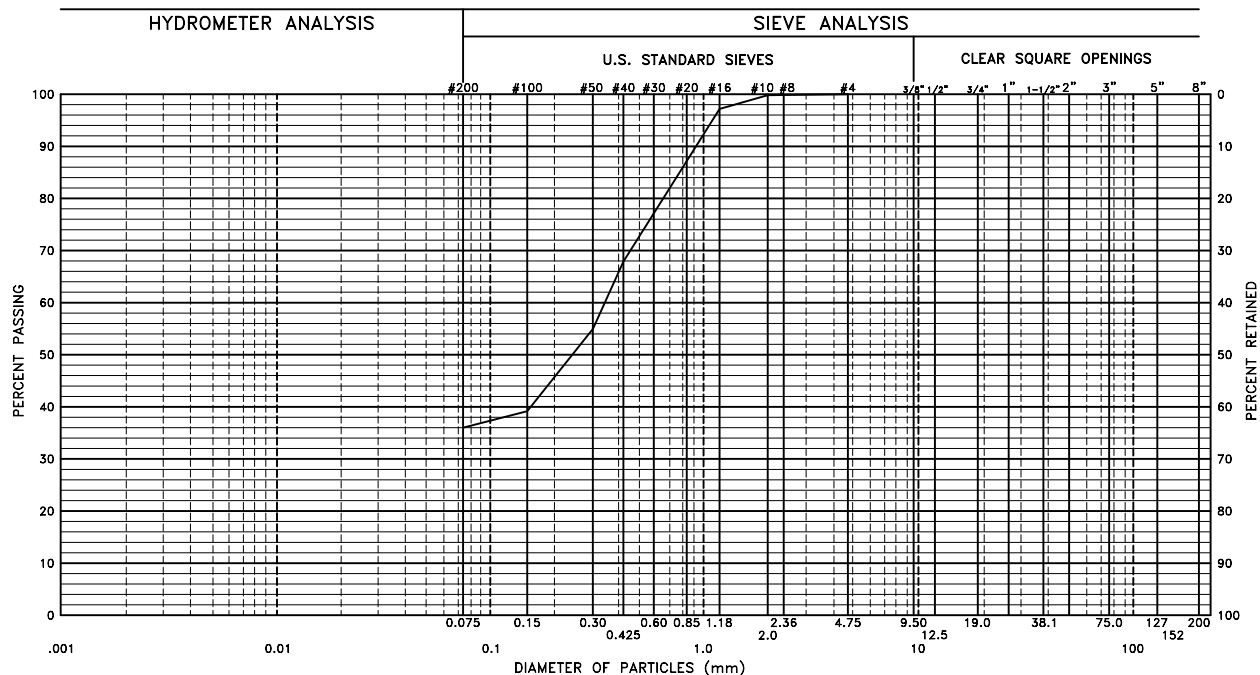
WC = WATER CONTENT (%) (ASTM D 2216);
DD = DRY DENSITY (pcf) (ASTM D 2216);
+4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D 422);
-200 = PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140);
LL = LIQUID LIMIT (ASTM D 4318);
PI = PLASTICITY INDEX (ASTM D 4318);
NP = NONPLASTIC (ASTM D 4318);
WSS = WATER SOLUBLE SULFATES (%) (HACH METHOD).

NOTES

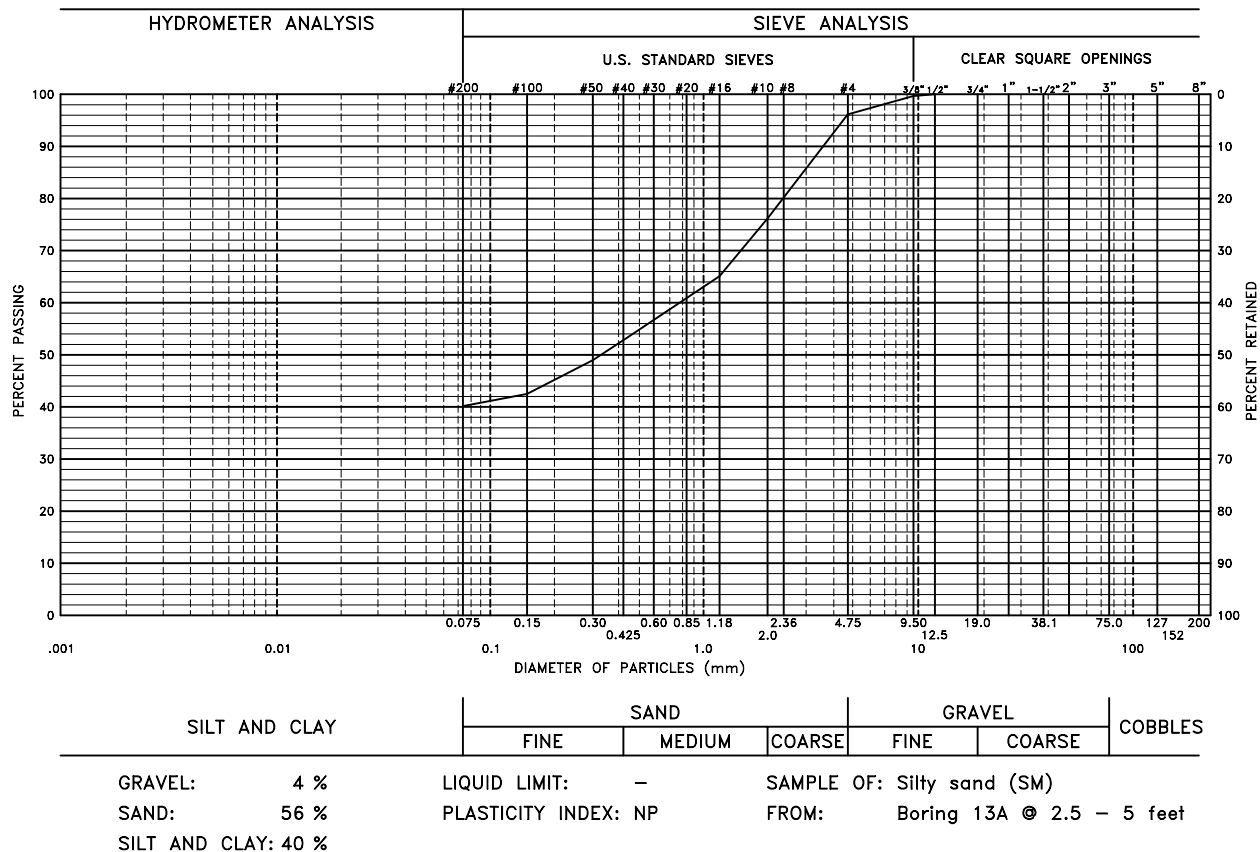
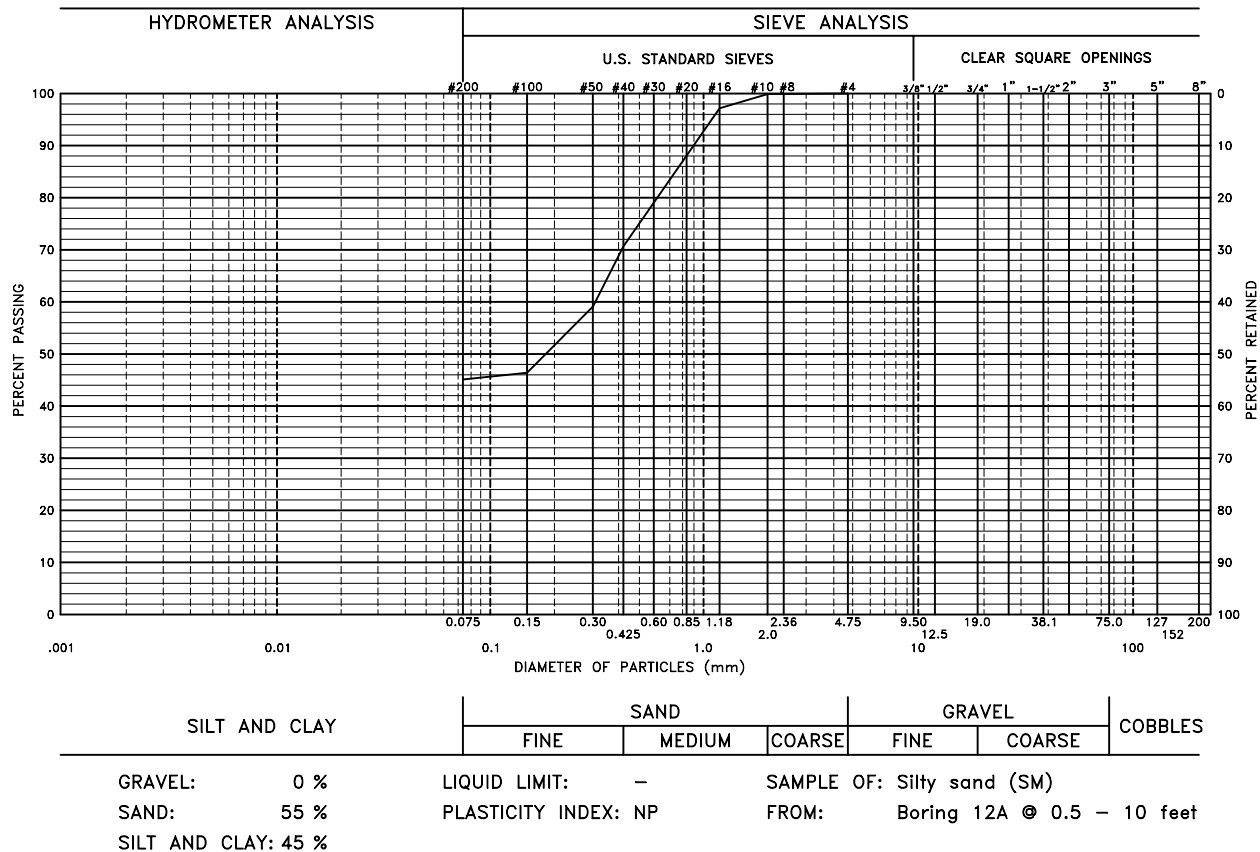
- THE EXPLORATORY BORINGS WERE DRILLED WITH A 4-INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER. BORINGS FOR THE FINAL GEOTECHNICAL ENGINEERING STUDY WERE DRILLED BETWEEN FEBRUARY 7 AND 9, 2007. BORINGS DRILLED FOR THE PRELIMINARY GEOTECHNICAL ENGINEERING STUDY WERE DRILLED ON NOVEMBER 9 AND 10, 2006.
- THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY TAPING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
- THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE OBTAINED BY INTERPOLATION BETWEEN CONTOURS ON THE SITE PLAN PROVIDED.
- THE EXPLORATORY BORING LOCATIONS AND ELEVATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
- THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
- GROUND WATER LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.

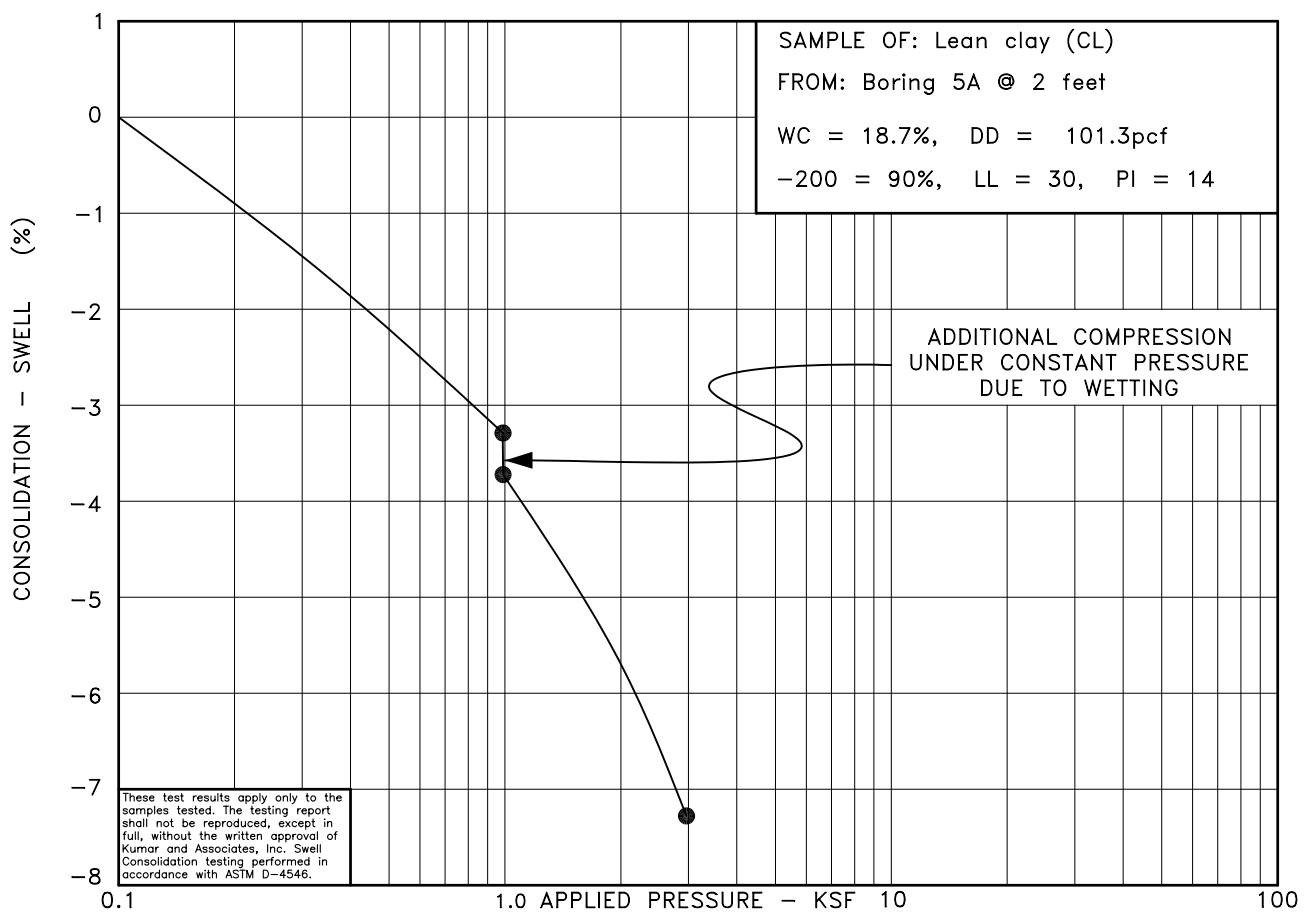
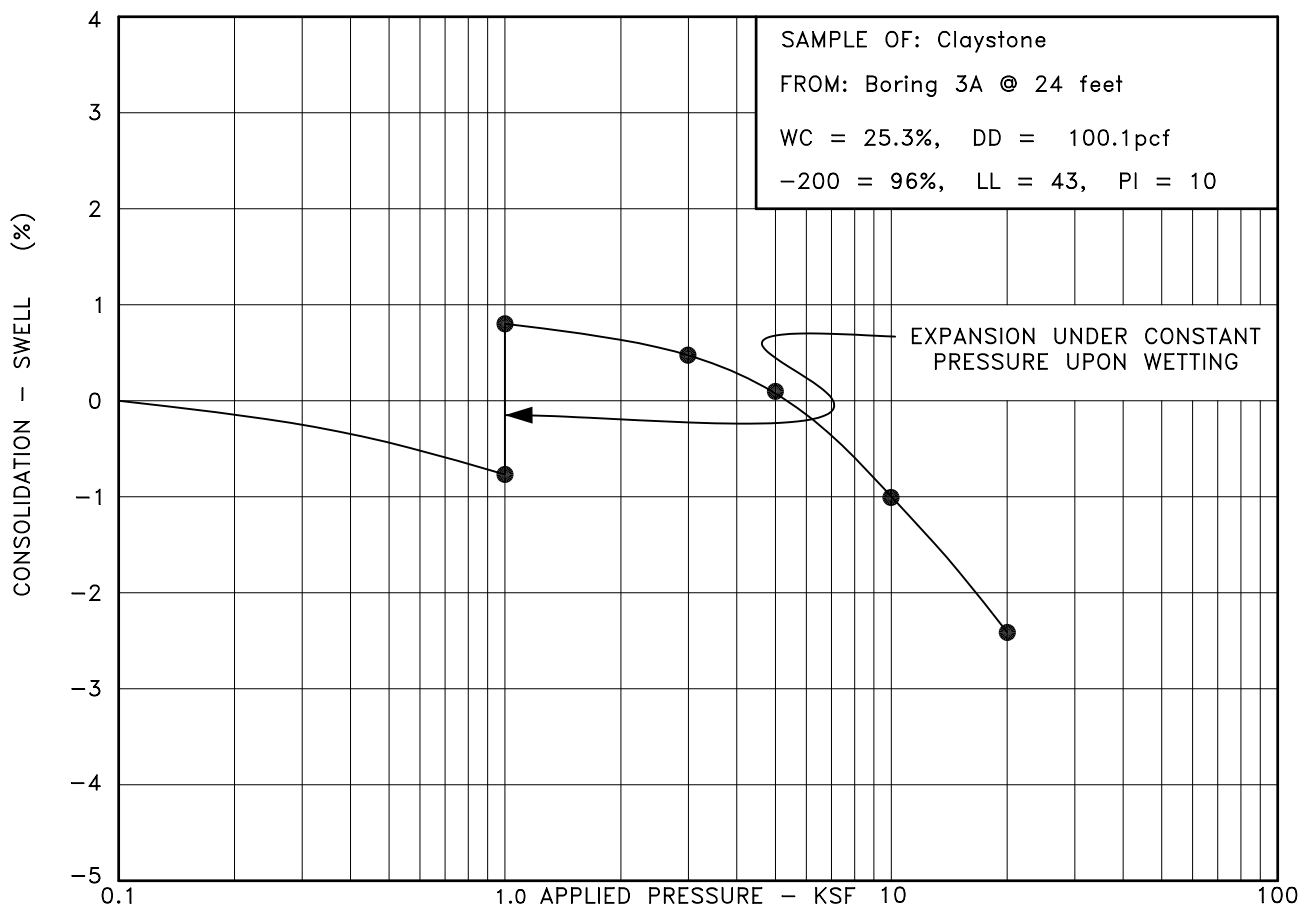


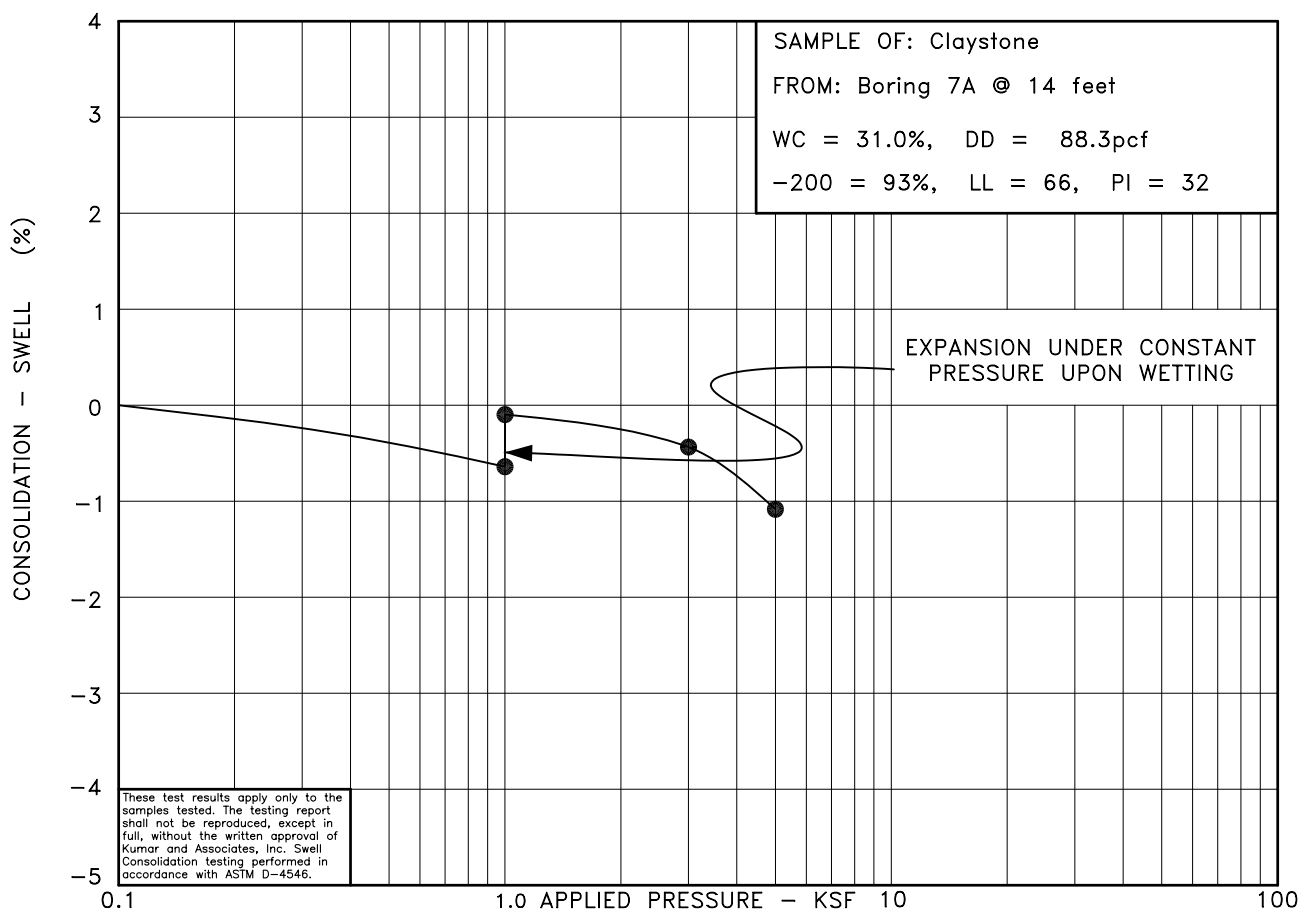
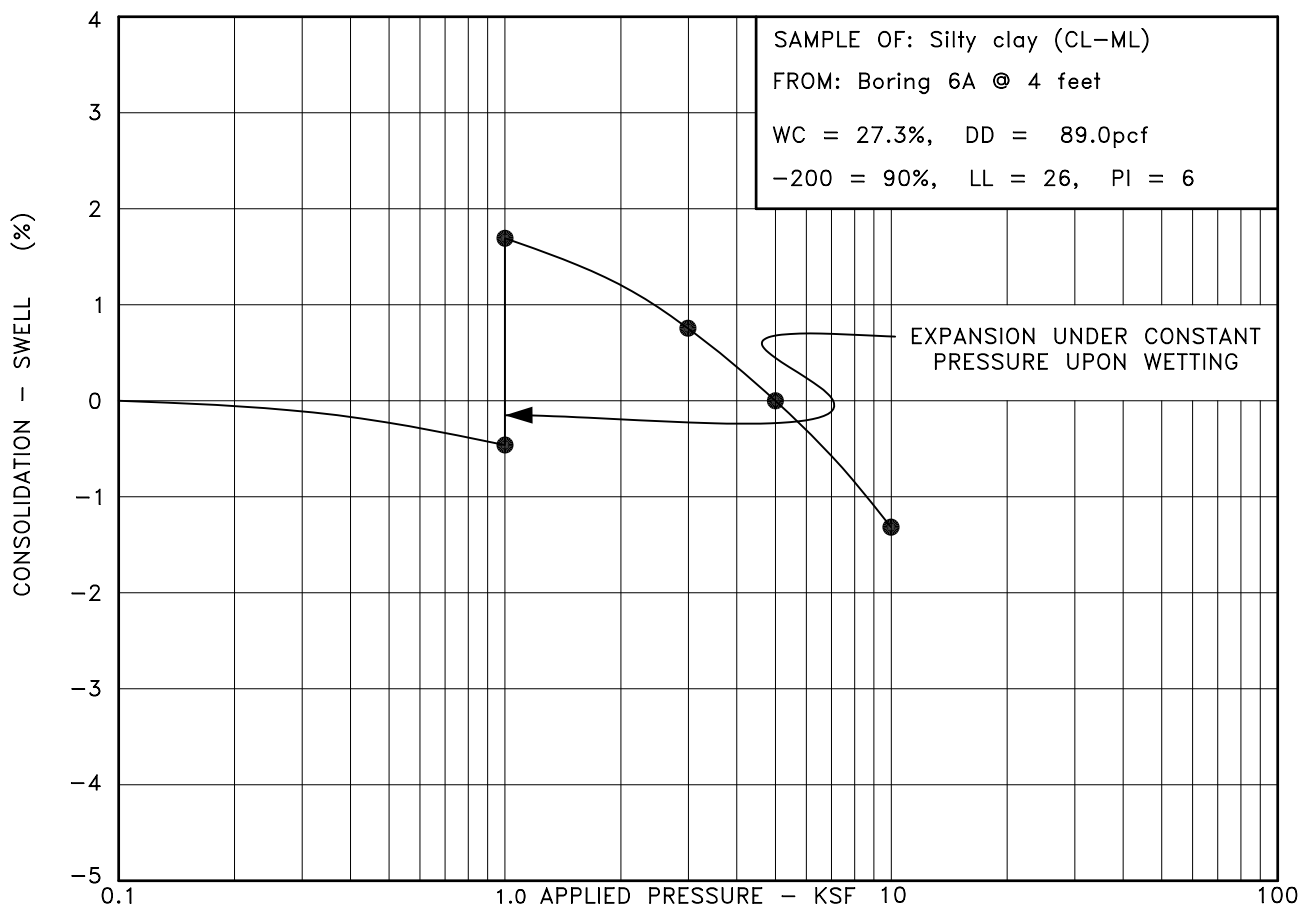
SILT AND CLAY	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	
GRAVEL: 0 %	LIQUID LIMIT: -			SAMPLE OF: Silty Sand (SM)		FROM: Boring 9A @ 0.5 - 5 feet
SAND: 56 %	PLASTICITY INDEX: NP					
SILT AND CLAY: 44 %						



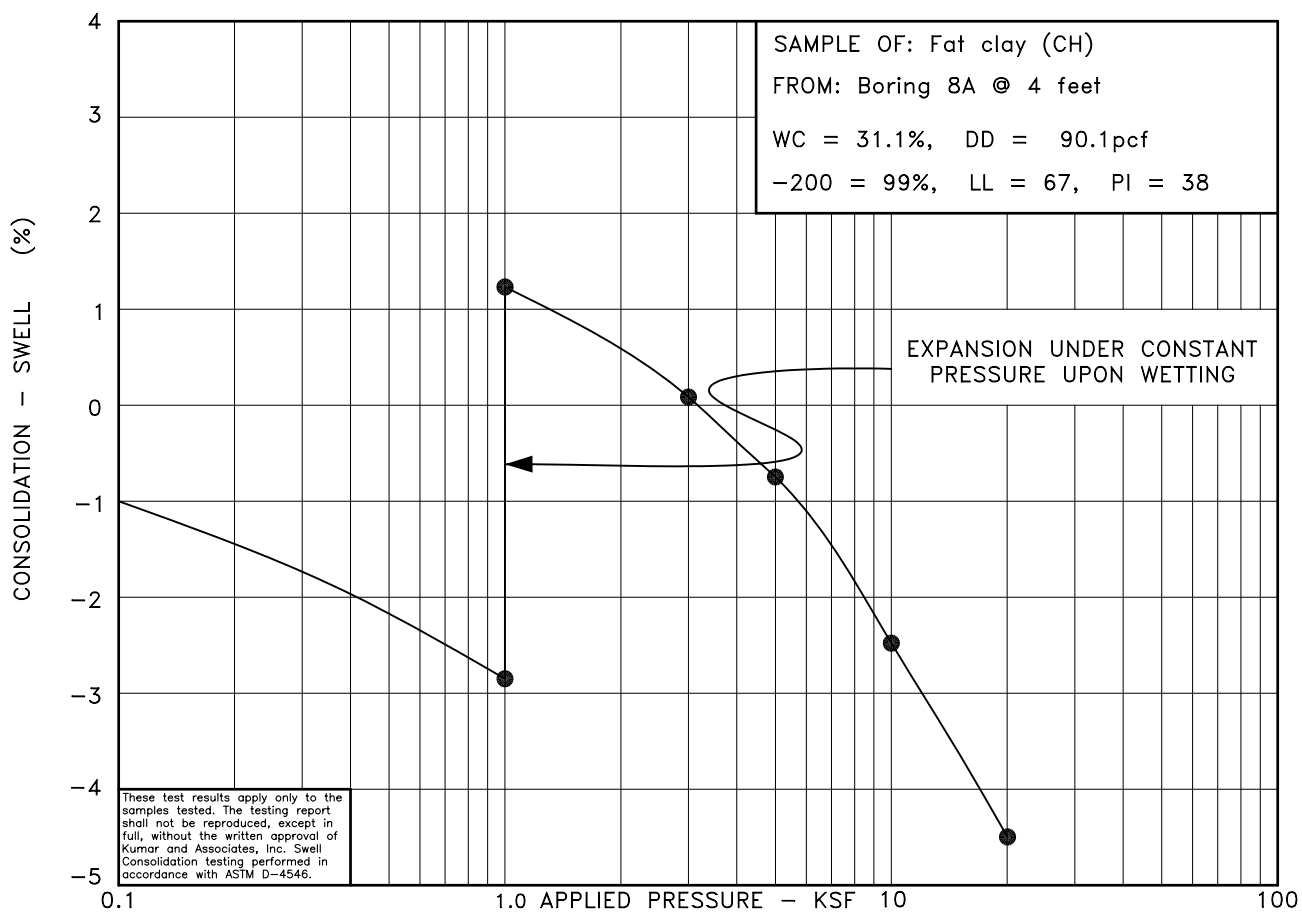
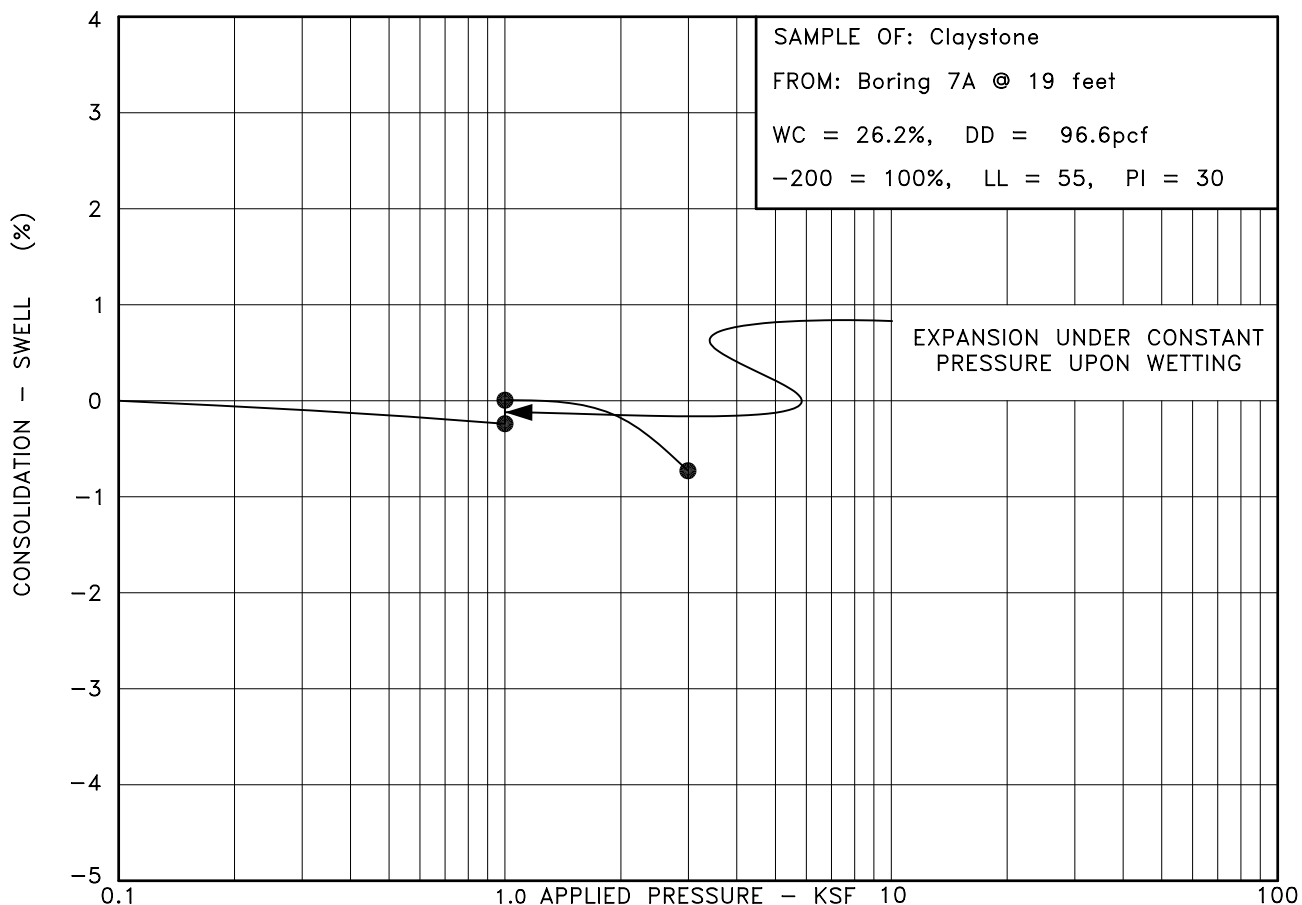
SILT AND CLAY	SAND			GRAVEL		COBBLES
	FINE	MEDIUM	COARSE	FINE	COARSE	
GRAVEL: 0 %	LIQUID LIMIT: -			SAMPLE OF: Silty sand (SM)		FROM: Boring 10A @ 4 - 12 feet
SAND: 64 %	PLASTICITY INDEX: NP					
SILT AND CLAY: 36 %						



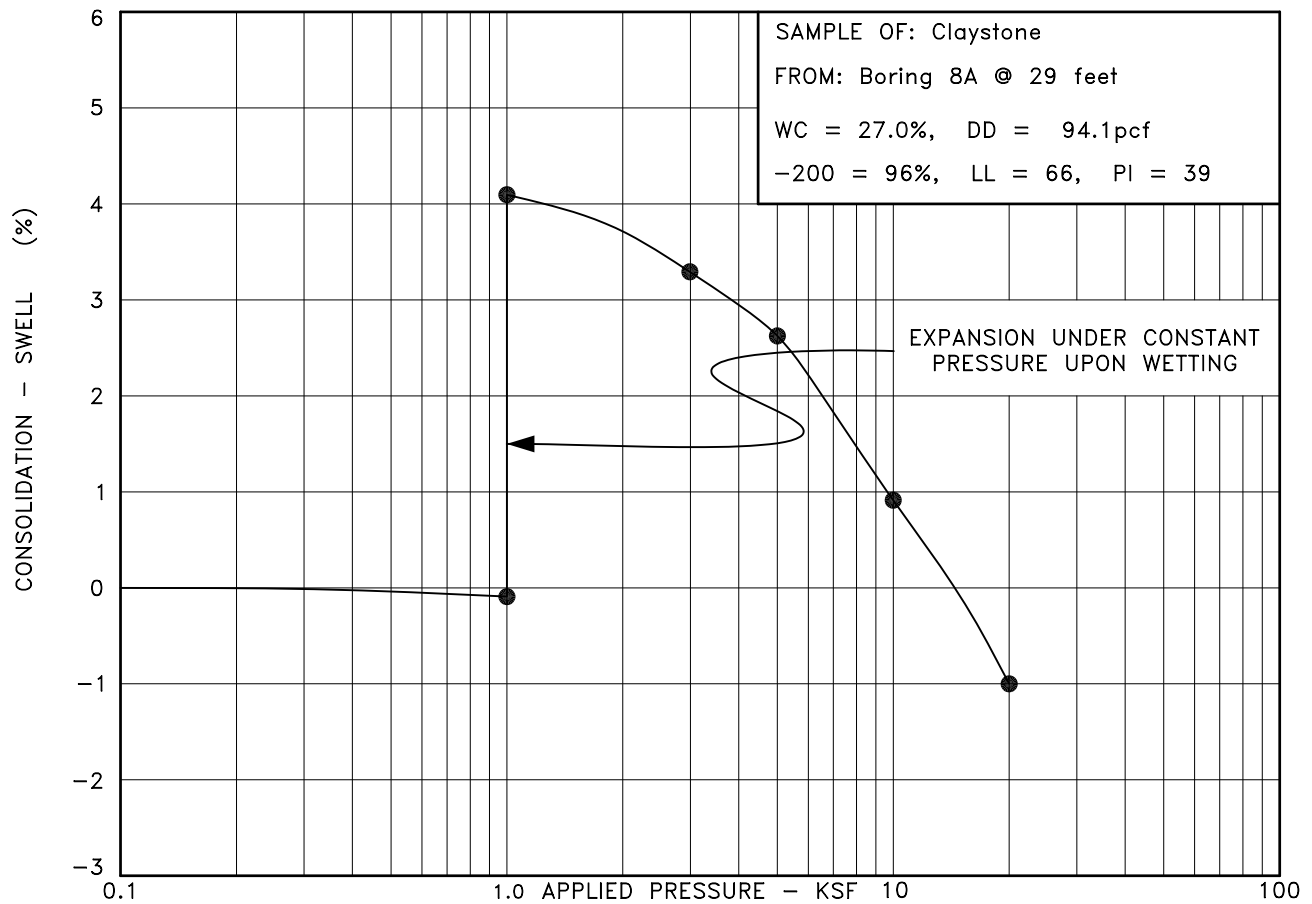


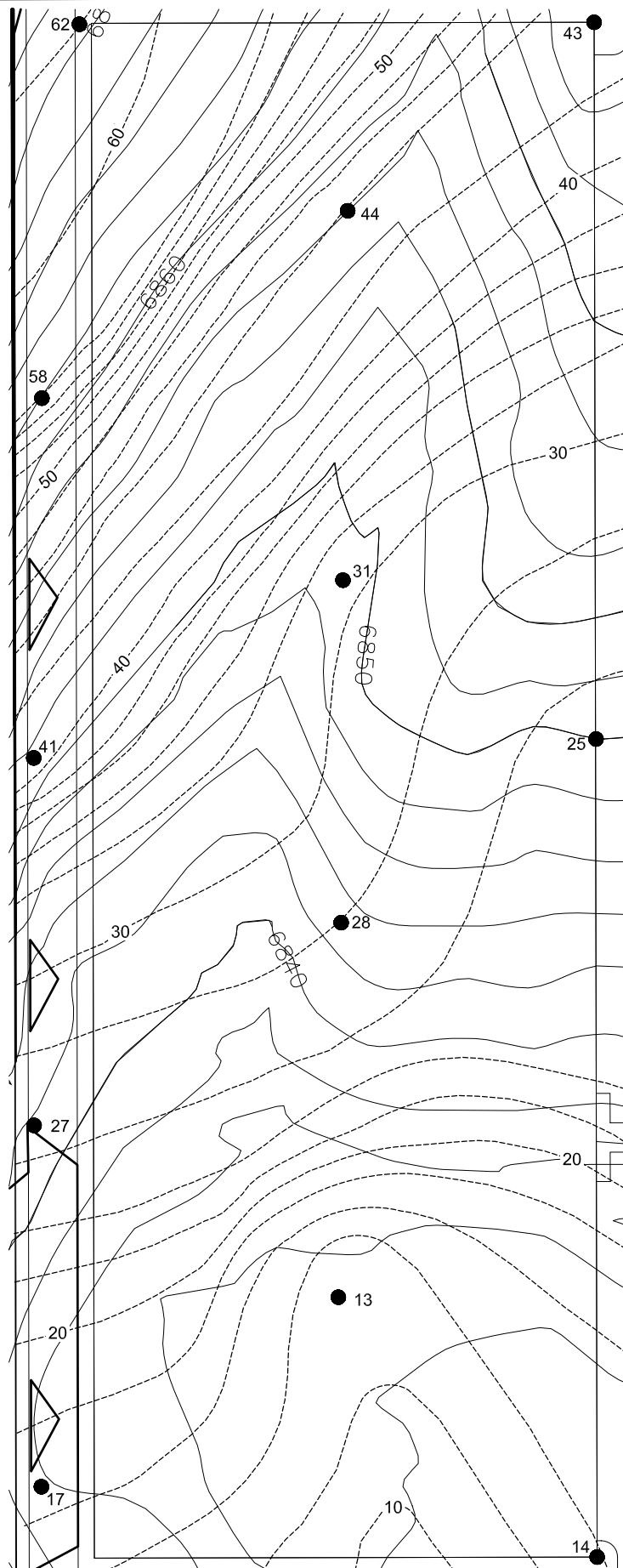


These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

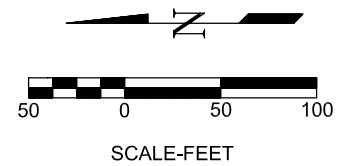


These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.





- EXISTING TOPOGRAPHY
- APPROXIMATE BEDROCK SURFACE CONTOUR
- BEDROCK ELEVATION AT BORING LOCATION. (17' = 6817')



Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 062-259.C

Project Name: American Furniture Warehouse

Date Sampled: 2/7/07 to 2/9/07

Date Received: 2/8/07 to 2/9/07

Page 1 of 2

[illegible]

Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 062-259.C

Project Name: American Furniture Warehouse

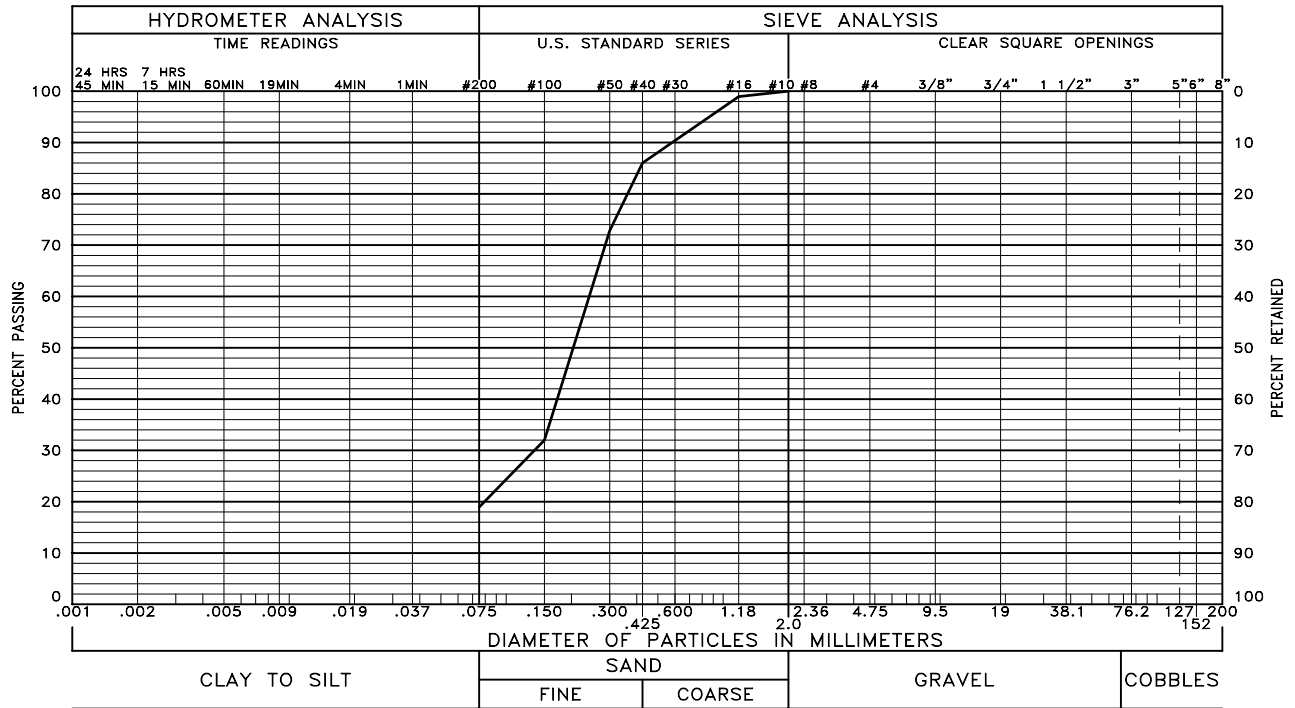
Date Sampled: 2/7/07 to 2/9/07

Date Received: 2/8/07 to 2/9/07

Page 2 of 2

[illegible]

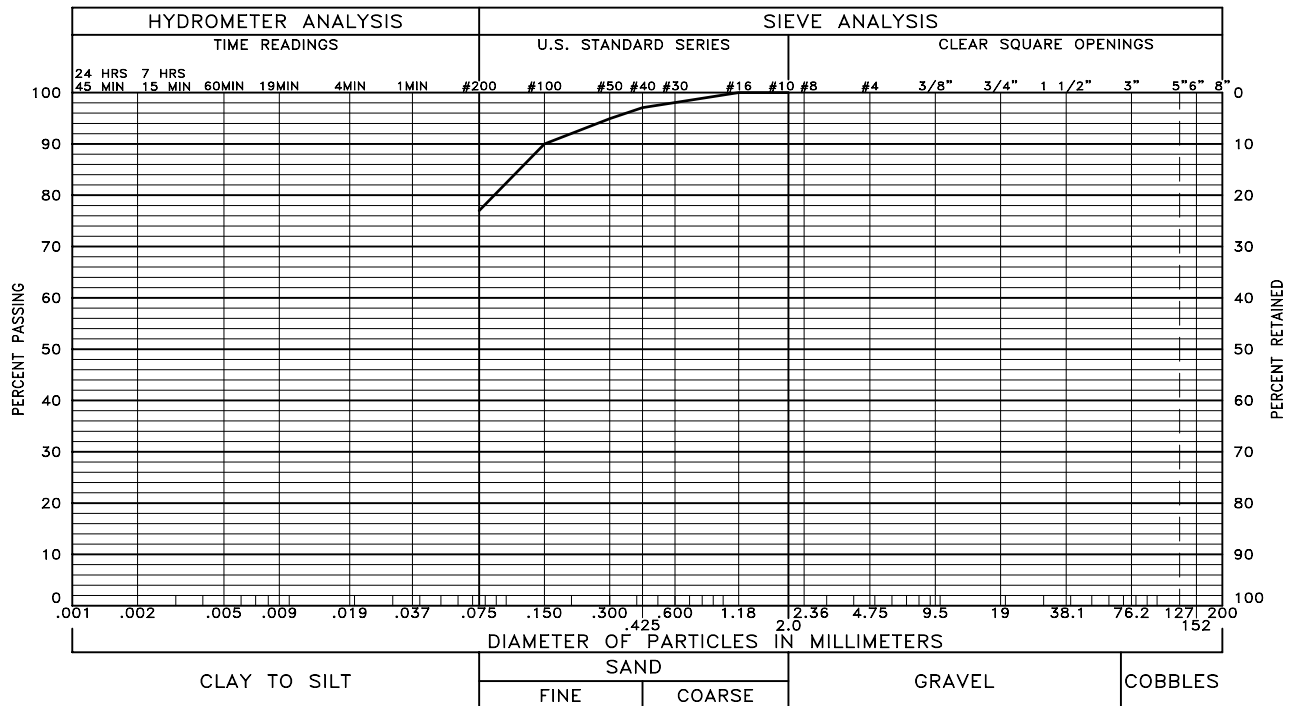
APPENDIX



GRAVEL 0% SAND 81% SILT AND CLAY 19%

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring 2 @ 9'

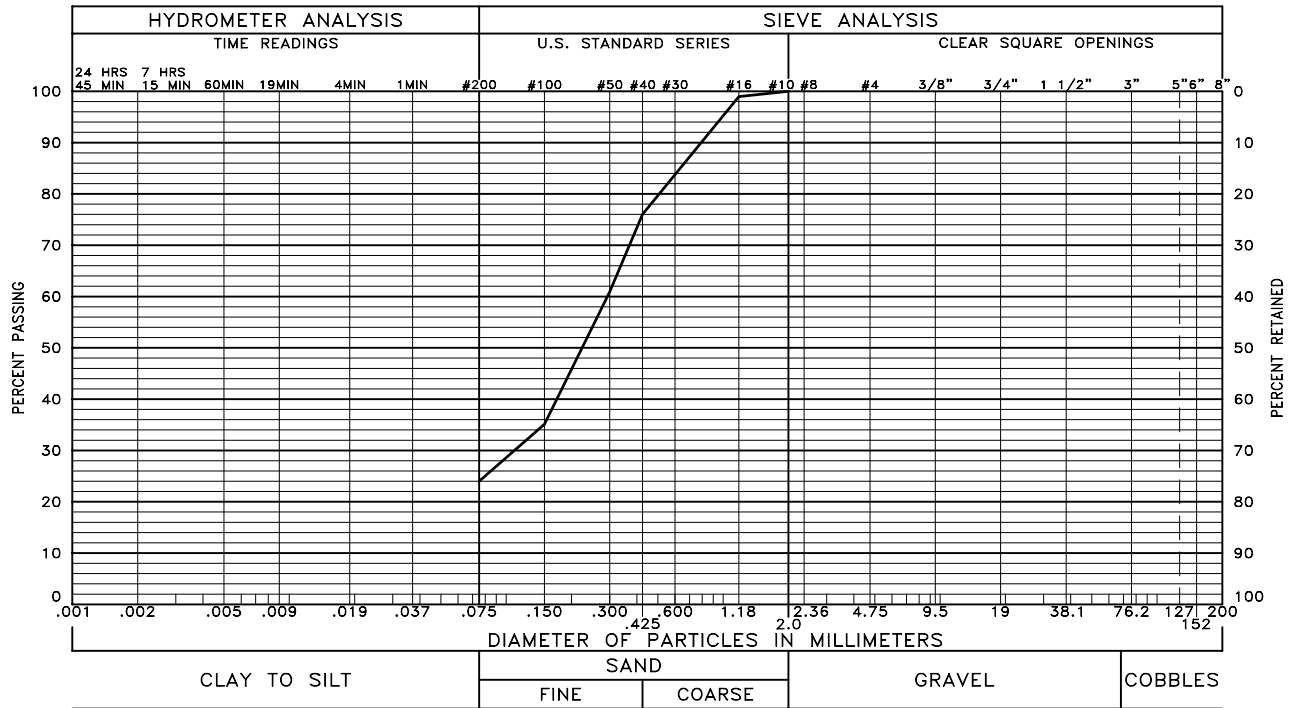


GRAVEL 0% SAND 23% SILT AND CLAY 77%

LIQUID LIMIT 30 PLASTICITY INDEX 11

SAMPLE OF: Lean Clay with Sand (CL) FROM: Boring 3 @ 4'

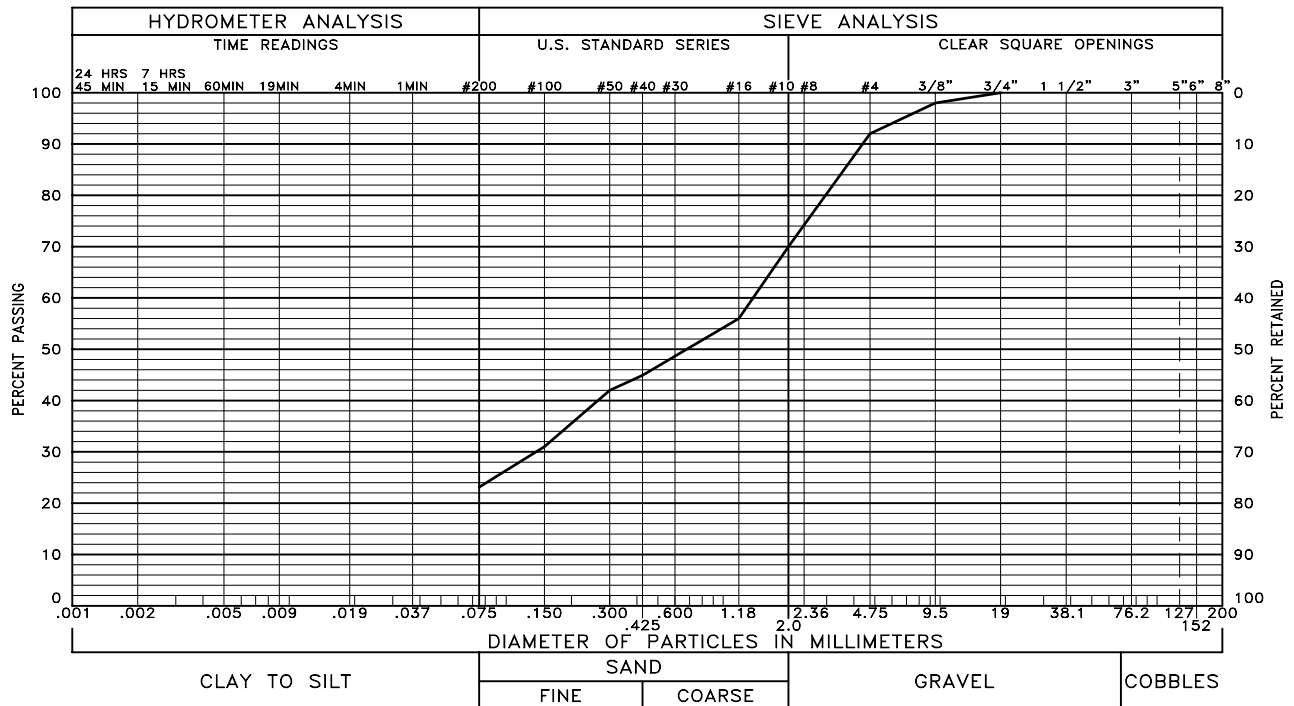
These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with AASHTO T-27 and/or T-88.



GRAVEL 0% SAND 76% SILT AND CLAY 24%

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring 10 @ 4'

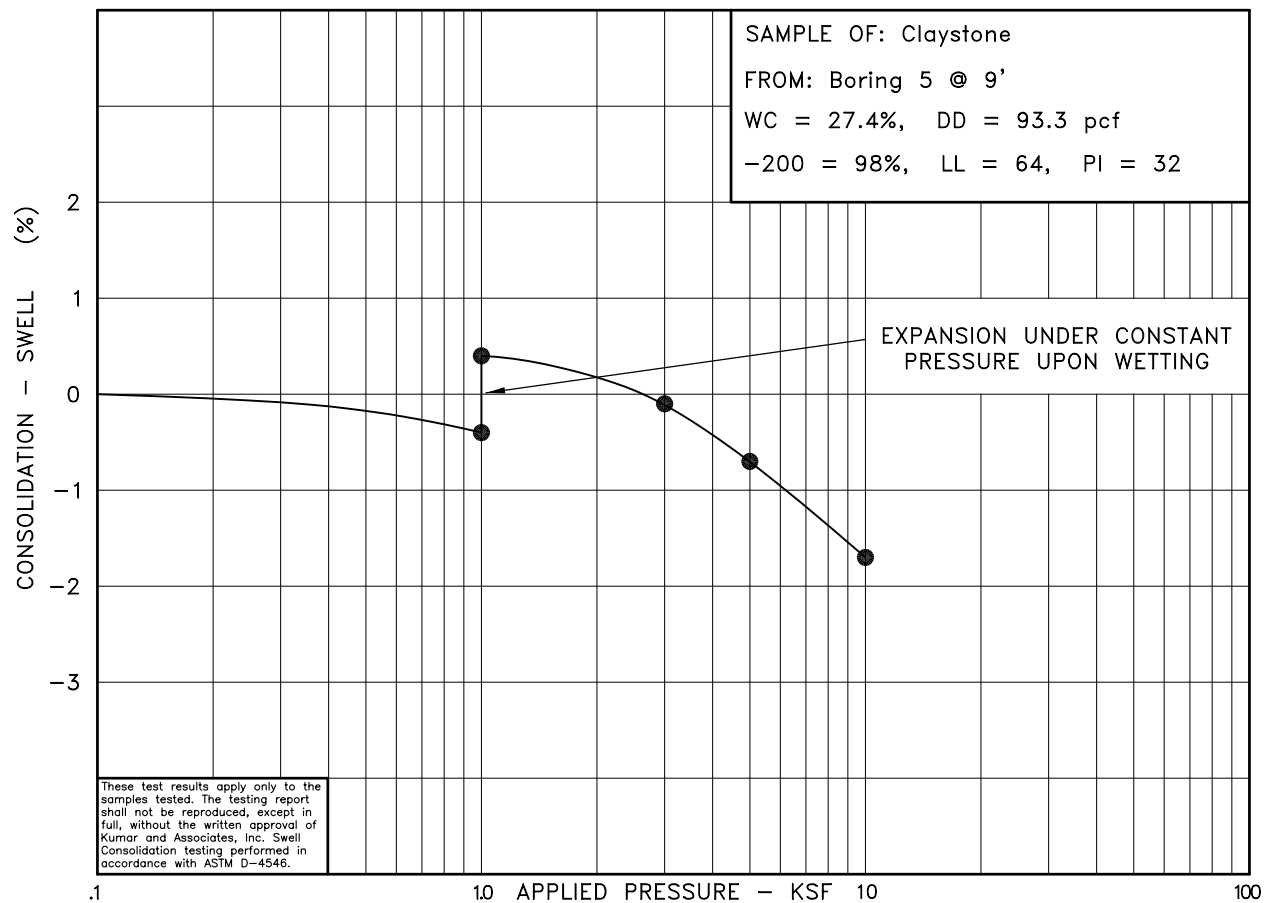
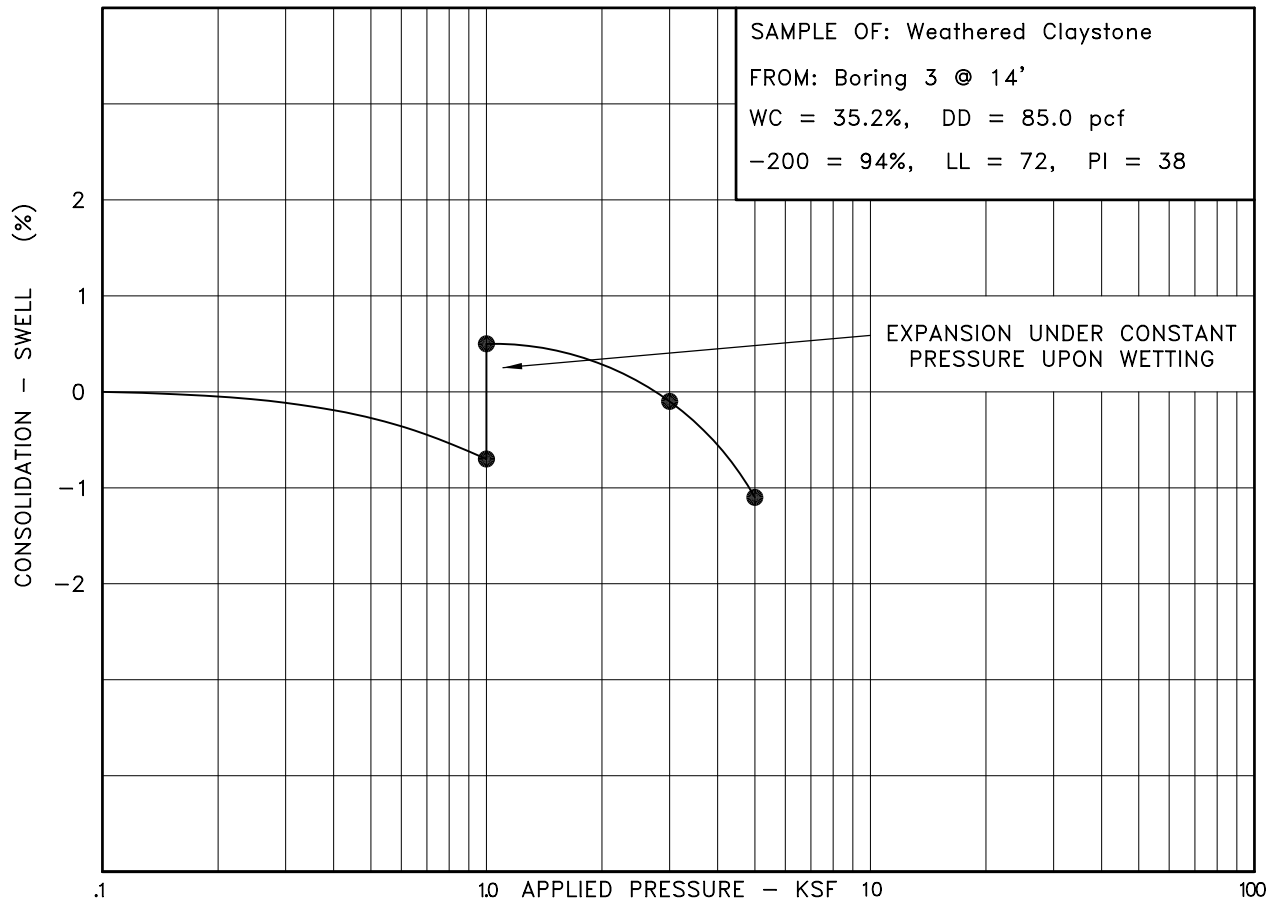


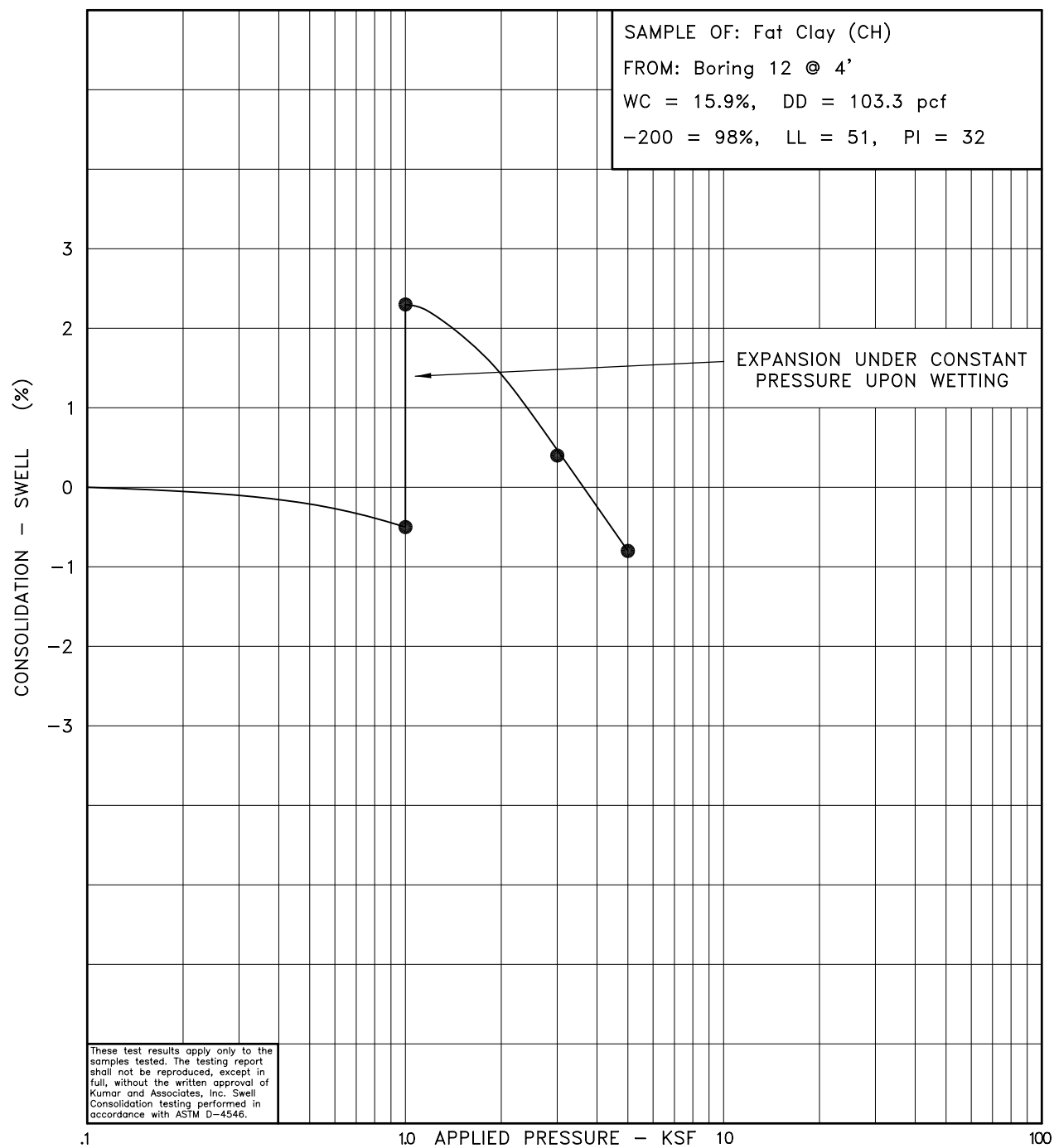
GRAVEL 8% SAND 69% SILT AND CLAY 23%

LIQUID LIMIT PLASTICITY INDEX NP

SAMPLE OF: Silty Sand (SM) FROM: Boring 17 @ 2'

These test results apply only to the samples which were tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar & Associates, Inc. Sieve analysis testing is performed in accordance with AASHTO T-27 and/or T-88.





Kumar & Associates, Inc.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Project No.: 062-259

Project Name: American Furniture Warehouse

Date Sampled: 11/9/06, 11/10/06

Date Received: 11/10/06

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	SOIL OR BEDROCK TYPE (Unified Soil Classification)
BORING	DEPTH (ft)				GRAVEL (%)	SAND (%)		LIQUID LIMIT	PLASTICITY INDEX		
2	9	11/15/06	12.6	105.5	0	81	19		NP		Silty sand (SM)
3	4	11/15/06	18.3	101.9	0	23	77	30	11		Lean clay with sand (CL)
	14	11/15/06	35.2	85.0			94	72	38		Weathered claystone
5	9	11/15/06	27.4	93.3			98	64	32	0.01	Claystone
10	4	11/15/06	5.9	105.2	0	76	24		NP		Silty sand (SM)
12	4	11/15/06	15.9	103.3			98	51	32	0.07	Fat clay (CH)
17	2	11/15/06	3.4	111.3	8	69	23		NP		Silty sand (SM)

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SECTION 01 10 00

GENERAL REQUIREMENTS of the WORK

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. This Section includes general conditions, provisions and requirements for Work covered by the Contract Documents and include the following:
1. Summary of Work
 2. Municipal Requirements
 3. General Requirement Provisions
 4. Payment Provisions
 5. Project Meetings
 6. Contractor Request for Information
 7. Submittals Procedures
 8. Product Substitutions
 9. Quality Control
 10. Progress Cleaning
 11. Cutting and Patching Procedures
 12. Project Closeout
- B. Scope of Work: Briefly, and without force and effect on the Contract Documents, the Work consists of construction of a one-story building of approximately 369,100 s.f. and related site and utility improvements. The Base Bid shall include performing and furnishing the Work required of the Contract Documents and providing the means, methods, equipment, techniques, construction procedures, design-build services, supervision, temporary power and utilities, and all labor and materials for construction of the Project.
- C. Project Identification:
1. Project Name: AFW - Colorado
 2. Project Location: Colorado Springs, Colorado.
 3. Owner: American Furniture Warehouse
- D. Project Consultants:
1. Architect: Butler Design Group
 2. Structural Engineer: PK Associates
 3. Mechanical Engineer: Kraemer Consulting Engineers
 4. Electrical Engineer: Kraemer Consulting Engineers
 5. Civil Engineer: Bowman
 6. Landscape Architect: Laskin & Associates
 7. Geotechnical Engineer: Kumar & Associates
- E. Contract Documents: The Contract Documents, dated October 15, 2024 and listed under Document 00 85 00 - Contract Drawing List, and indicate the scope of the Contract and related requirements and conditions to be anticipated in performing the Work.
1. Project Coordinator: Toby Rogers with Butler Design Group, may be contacted with questions regarding the Project Bid Documents.
- F. Owner-Furnished Items: The following Work has been or will be provided by the Owner under separate contract or agreement in addition to other items of Work where indicated as "NIC" or "Not in Contract".
1. Public Utility Coordination: Off-site water line taps to be performed by City forces.
 2. Soil Investigation: Geotechnical soil sampling has been performed and the results of which will be made available to the Contractor.

1.02 MUNICIPAL REGULATORY REQUIREMENTS

- A. Code Summary:
1. Floor Areas:
 - a. Warehouse: 211,385 s.f.
 - b. Showroom: 123,475 s.f.
 - c. Warehouse mezzanine: 34,240 s.f.
 2. Occupancy Type: S-1 and M.
 3. Construction Type: V-B
 4. Fire-Resistance Requirements:
 - a. Exterior Walls: None required 20' or greater from property line.
 - b. Structural Frame: 0 Hour.
 - c. Mezzanine Floor and Roof: 0 Hour.
- B. Code Regulations: The following applicable governing codes and standards will regulate and require conformance with the design and construction of the Project. Obtain copies and retain at the Project site to be available for reference by parties who have a reasonable need to reference:
1. International Building Code - 2021
 2. International Mechanical Code – 2021
 3. International Plumbing Code – 2021
 4. National Electrical Code – 2017
 5. International Energy Conservation Code – 2021
 6. International Fire Code – 2021, as amended.
 7. 2009 ICC A117.1 Standards for Accessible Design
 8. City of Colorado Springs Building Code Amendments.
- C. Permits, Licenses, and Certificates: Maintain copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.
- D. Permits and Fees: The following fees and permits will be secured by the Owner:
1. Building Permit and Building Plan Review
 2. On-site Grading & Drainage Permit and Plan Review
 3. Off-site Paving and Off-site Utility Permits and Plan Review.
 4. Water & Sewer Development Fee
 5. Development Impact Fees.
 6. Electrical Utility Connection Fee.
- E. The Contractor shall secure and pay for all other permits, licenses and inspections necessary for the proper and lawful completion of the Work. This includes, but is not limited to:
1. Haul Permits
 2. Temporary Street Closures
 3. Traffic Control Permits
 4. Temporary Construction Fencing
 5. Dust Control Permits
- F. Deferred Submittals: Submit copies of the following final submittals to authorities having jurisdiction (AHJ) with review stamp indicating review by the Architect or Engineer of Record.
1. Fire-Sprinkler System and Hydraulic Calculations
 2. Fire-Alarm System
 3. Pre-fabricated Steel Joists and Calculations
- G. The Contractor shall comply with and give notices required by laws, ordinances, regulations and lawful orders bearing on the performance of the Work. If the Contractor performs Work knowing it to be contrary to such laws, ordinances and regulations, without written notice to the Owner, the Contractor shall assume the responsibility for fines, penalties and corrected work attributable thereto.
1. It is not the responsibility of the Contractor to make certain that the Contract Documents are in compliance with applicable laws, statutes, codes or building regulations. If the Contractor believes that any component of the Contract Documents are at variance therewith in any respect, he shall give prompt written notice to the Architect or Owner, as applicable.

1.03 GENERAL REQUIREMENT PROVISIONS

- A. Use of Premises: During the construction period the Contractor shall have full use of the premises for construction operations, including use of the site. The Contractor's use of the premises is limited only by the Owner's right to store materials or perform undetermined operations with its own forces or to employ separate contractors on portions of the project.
1. Hours of Operation shall be limited to the hours lawfully stipulated by the Town of Marana.
- B. General Provisions: General Conditions for the Work shall include the following:
1. Supervision Cost: Field supervisory personnel assigned to the Project, wherever employed in connection with the Work. Cost to include salaries, welfare and fringe benefits, including vacation, sick time, holidays, health, life and hospitalization insurance, company vehicles, unemployment and Worker's Compensation, Social Security and any other remuneration paid to Contractor's employees. For purposes of this Section, personnel include field engineers and general superintendents.
 2. Field Office: The cost of Contractor's field office and equipment, reproduction cost, office supplies, first-aid supplies, small tools and related items incurred in connection with the Work.
 3. Security: The cost of job site security, temporary fencing and security services.
 4. Refuse Disposal: The cost to provide and maintain containers, haul and dispose of debris resulting from the Work.
 5. First-aid: The cost to provide and maintain safety and first-aid supplies for general emergency purposes.
 6. Drinking Water: The cost to provide and maintain ice and drinking water for construction personnel.
 7. Fire-Protection: Cost to provide fire-protection measures to protect premises, including fire-extinguishers.
 8. Preconstruction Services: Cost to prepare and update project schedules and cost/budget projections during the period of construction.
 9. Utility Consumption: Cost of water, sewer, and electrical consumption during the period of construction.
 10. Safety Precautions: Cost to provide safety equipment and measures, including barriers, safety programs and implementation, construction signage and posted notices, lighting, safety-program personnel and inspections.
 11. Insurance: Cost of insurance in the amounts and coverages required under Base Bid General Conditions and Supplemental Conditions, for the period of construction. Include losses or expenses not compensated by insurance including deductibles for losses and expenses for which the General Contractor is responsible. Losses and expenses attributable to subcontractors shall be the responsibility of the subcontractor.
 12. Sanitary Facilities: The cost to provide and maintain temporary toilet facilities.
 13. Protection of Premises: Cost to protect existing facilities and adjacent property.
 14. Clean-up: Cost for labor and materials to clean areas affected by the Work and surrounding premises.
 15. Material Expediting: Cost of travel and related measures required to expedite materials and the delivery to the Project, relative to the general contractors work.
 16. Construction Signage: Cost for signage required for construction activities, traffic control, barricades and safety.
 17. Fines: Fines from OSHA or other governing agencies related to the means and methods of performing the Work.
 18. Surveying: Cost of labor and materials to locate or verify location of items for conformance with the Work and coordination between general contractor's subcontractor.
 19. Corrective Work: Cost to provide labor and materials required for coordination and correction of defective Work and Warranty/Guarantee obligations.
- C. Specification Format: The Specifications are organized into Divisions and Sections using the CSI Format numbering system.
1. Section Identification: The Specifications use section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of sections in the Contract Documents.

2. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
3. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated and meanings shall be interpreted as appropriate. Singular words shall be interpreted as plural and plural words shall be interpreted as singular where applicable as the context indicates.

1.04 PAYMENT PROVISIONS

- A. Payment Application Form: The form of Application for Payment shall be a notarized AIA Document G702, Application and Certification for Payment, supported by approved AIA Document G703, Continuation Sheet, indicating the scheduled value of major categories and subcontracts for the Work. Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
- B. Waivers of Mechanic's Lien: With each Application for Payment, submit partial waivers of mechanic's liens from subcontractors, sub-subcontractors, and suppliers for construction period covered by the previous application.
- C. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted.

1.05 PROJECT MEETINGS

- A. Pre-construction Conference: Schedule a pre-construction meeting before starting construction, at a time convenient to Owner and their representatives, but no later than 15 days after execution of the Agreement. Hold the conference at Project site or other agreed upon location.
- B. Progress Meetings: Conduct progress meetings at bi-monthly intervals at Project site. Coordinate dates of meetings with preparation of payment requests.
 1. Attendees: In addition to representatives of Owner, Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings.
 2. Agenda: Review and correct or approve minutes of previous progress meeting. Review items of significance that could affect progress as appropriate to status of Project.
 3. Contractor's Construction Schedule: Update and review progress since the last meeting.
 4. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Owner and Architect, within 3 days of the meeting.
- C. Coordination Meetings: Conduct Project coordination meetings at intervals necessary to maintain the progress of the Work. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings.

1.06 CONTRACTOR'S REQUESTS FOR INFORMATION

- A. General: Contractor shall endeavor to keep the number of RFI's to a minimum and shall carefully study the Contract Documents to assure that the requested information is not available therein.
- B. RFI's shall be submitted by the Contractor and properly prepared to include a detailed written statement that indicates the specific Drawings or Specification in need of clarification and the nature of the clarification requested.
 1. Forms shall be completely filled in and attachments fully legible.
 2. RFI's shall be submitted and logged in numerical order.
 3. Each page of attachments to RFI's shall bear the RFI number and shall be consecutively numbered in chronological order.
 4. RFI's from subcontractors or material suppliers shall be submitted through, reviewed by, and signed by the Contractor prior to submittal to the Architect.

5. RFI's shall be submitted by email.
- C. Contractor shall allow up to five (5) working days for response to RFI'S, unless review is required of multiple consultants, then the response period shall be seven (7) working days.
 1. RFI shall state requested date/time for response, however, this requested date/time for response is not a guarantee that the RFI will be answered by that date/time.

1.07 SUBMITTAL PROCEDURES

- A. General: Electronic copies in read-only format (PDF) of contract drawings will be provided for Contractor's use in preparing submittals. The following documents will be made available in Autocad format only:
 1. Grading and Drainage Site Plan
 2. Architectural Site Plan
 3. Architectural Floor Plans
 4. Architectural Ceiling Plans
 5. Architectural Building Elevations
 6. Structural Foundation Plans
 7. Structural Roof Framing Plans
- B. Procurement and Submittals Schedule: Prepare a master list of submittals with anticipated date of each initial submittal as it relates to sequence of construction activities.
 1. Allow (10) ten working days for initial review of each submittal. Schedule enough time for submittal review by Contractor prior to submission to Architect.
 2. Allow (5) five working days for subsequent review of resubmittals.
 3. Coordinate sequence of submittals with sequence of construction activities. Do not submit submittals more than sixty (60) days prior to when material is needed on jobsite.
- C. Transmittal: Package each submittal individually and appropriately for separate review. Number each transmittal in numerical sequence of date submitted. Architect will return submittals, without review, without sequential transmittal numbering.
 1. Where a submittal is not a specified or prior approved manufacturer or substitution, include Contractor's certification stating that information submitted complies with requirements of the Contract Documents and reason for substitution.
 2. Architect will discard submittals, without review, received from sources other than Contractor.
- D. Product Data Submittals: Submit in electronic format only, in a single submittal for each element of construction and type of product or equipment.
 1. If manufacturer's standard Product Data must be specifically modified to meet compliance with Project requirements, submit as Shop Drawings, not as Product Data.
 2. Mark each submittal to show which products and options are applicable to the Project, by location and specific specification paragraph reference.
- E. Shop Drawing Submittals: Submit in electronic format only, prepared with project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents.
 1. Review each submittal for compliance with the Contract Documents. Note corrections, modifications, exceptions and field dimensions. Mark with review stamp indicating that the submittal has been reviewed, checked, and in Contractor's opinion in compliance with the Contract Documents. Architect will not review submittals that do not bear Contractor's review stamp and will return them without action.
 2. Review Stamp: Stamp each submittal with a review stamp that indicates Project name and location, submittal number, Specification Section title and number, name of reviewer and date of Contractor's review.
 3. The Architect's or Consultant's review of Contractor's submittals will be limited to an initial submittal review and one resubmittal review.
 4. Submittals with the Design Architect's or Consultant's logo, professional seal or title block will be returned without review.
 3. Submittal Review: Architect will review each submittal, make marks to indicate corrections or modifications required, and stamp and return each submittal with an action stamp to indicate action taken, as follows:

- a. REVIEWED: That part of the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents.
 - b. REVIEWED AS NOTED: That part of the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Resubmittal is not required unless Contractor is at variance with comments noted.
 - c. REVISE AND RESUBMIT: Do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay.
 - d. REJECTED: That part of the Work indicated on the submittal does not comply with requirements of the Contract Documents or is insufficiently complete to review. Do not proceed with that part of the Work covered by the submittal, including purchasing, fabrication, delivery, or other activity.
- D. Information Only Submittals: Prepare and submit Informational Only Submittals required by other Specification Sections that are required for the Project Records. Informational Only Submittals will not be reviewed or returned to the Contractor and include the following:
- 1. Welding Certificates
 - 2. Material Test Reports
 - 3. Research/Evaluation Reports
 - 4. Structural Calculations
- F. Samples: Prepare full-size or in the size and manner specified, fully fabricated Samples, cured and finished as proposed to be installed in the Work. Prepare samples at the Project site to facilitate review and approval of qualities specified or variations anticipated. Include the following:
- 1. Comply with requirements in specific specification sections for mockups.
 - 2. Maintain approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Approved Samples will be used to determine final acceptance of construction associated with each sample.
- G. Construction Schedule: Prepare and submit a CPM network-diagram type schedule, broken down by Trade or Material, prior to the first submittal of shop drawings, and shall show proposed starting and completion dates for each Trade and activity for the Work.
- 1. Submit updated schedule with each Pay Application.
- H. Construction Photographs: Take a minimum of four, digital color photographs, and submit with each monthly Pay Application.

1.08 PRODUCT SUBSTITUTION REQUEST

- A. Substitution Requests: Submit electronic PDF copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
- 1. Documentation: Show compliance with requirements for substitutions and the following:
 - a. Statement indicating why specified material or product cannot be provided.
 - b. List of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
 - c. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - d. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - e. Research/evaluation reports evidencing compliance with building code in effect for Project.
 - f. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
 - g. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
 - 2. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within one week of receipt of a request for substitution.
 - a. Form of Acceptance: Field Bulletin listing approved substitutions.

3. The Contractor's inclusion of a product substitution as part of a Shop Drawing or Product Data submittal does not constitute a valid request for or approval of a substitution, regardless of whether the submittal is subsequently approved in whole or in part.

1.09 QUALITY CONTROL

- A. Owner Responsibilities: The Owner will employ and pay for the services of an independent agency to provide inspections, tests and similar quality control services specified to be performed by independent agencies and not by the Contractor.
 1. Costs for retesting and reinspecting construction that replaces or is necessitated by work that continues to fail to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: The Contractor shall provide testing agency services required to meet the requirements of the Contract Documents and not otherwise provided by the Owner. The Contractor shall cooperate with agencies performing required inspections, tests and similar services and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance to permit assignment of personnel performing test and inspections so as not to delay the Work.
- C. General: Provide safe access to all work for inspectors and testing agency representatives to perform required testing and inspections, including but not limited to, fall protection, open-trench shoring, railings and structurally secure scaffolding.
- D. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
- E. Reports: Prepare and submit certified written reports that include the following:
 1. Project identification and entity responsible for performing tests and inspections.
 2. Dates and locations of samples and tests or inspections.
 3. Ambient conditions at time of sample taking and testing and inspecting.
 4. Indication of whether Work complies with the Contract Document requirements.
- F. General: The Testing Agencies and Special Inspectors employed by the Owner directly shall provide inspections and testing of the Work listed below and as required by the Municipal AHJ and as listed in other Sections of these Specifications.
 1. Section 03 30 00 – Cast-in-Place Concrete
 - a. Steel Reinforcing Inspection Reports.
 - b. Concrete Strength Test Reports.
 - c. Slab-on-Grade Flatness and Levelness Testing.
 - d. Floor Joint Sealant application Inspections.
 2. Section 03 47 00 – Site-Cast Tilt-Panel Concrete
 - a. Steel Reinforcing Inspection Reports (excluding lift insert embeds).
 - b. Concrete Strength Test Reports.
 3. Section 04 22 00 – Concrete Unit Masonry
 - a. Steel Reinforcing Inspection Reports.
 - b. Grout Strength Test Reports.
 - c. Water-Penetration Test (building walls only) Reports.
 4. Section 05 12 00 – Structural Steel Framing
 - a. Welded and bolted connections reports for shop fabrications requiring special inspections.
 - b. Welded Connection Inspection Reports.
 - c. Bolted Connection Inspection Reports.
 5. Section 05 31 13 – Steel Decking
 - a. Roof Deck: Initial Welding Inspection Reports.
 - b. Roof Deck: Final Welding Inspection Reports.
 - c. Floor Deck: Initial Welding Inspection Reports.
 - d. Floor Deck: Final Welding Inspection Reports.
 6. Section 05 40 00 – Cold-Formed Metal Framing
 - a. Welding Inspection Reports.
 - b. Fastener Inspection Reports.
 7. Section 07 24 16 – Exterior Insulation Finish System

- a. Initial Inspection Reports prior to Finish Top-coat application.
- 8. Section 07 54 00 – Membrane Roofing
 - a. Roof deck insulation board attachment Inspection Reports.
- 9. Section 08 42 00 – Aluminum Storefronts and Curtainwalls
 - a. Water-Penetration Test Reports.
- 10. Section 31 20 00 – Earthwork
 - a. Soils/building pad Compaction Test Reports.
 - b. Utility trench backfill Inspection Reports.
 - c. Pavement subgrade preparation Compaction Test Reports.
 - d. Concrete pavement Steel Reinforcing Inspection Reports.
- 11. Section 31 31 20 – Soil Treatment
 - a. Termiticide application rate Test Reports.

1.10 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
- B. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- C. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

1.11 CUTTING AND PATCHING

- A. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. Concrete and Masonry: Cut using machinery, such as an abrasive saw or a diamond-core drill.
 - 4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
 - 5. Proceed with patching after construction operations requiring cutting are complete.
- B. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
 - 1. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
 - b. Restore damaged pipe covering to its original condition.
 - 2. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
 - a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch.
 - 3. Ceilings: Patch and repair in-place damaged ceilings to provide a uniform surface and appearance.

4. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
- C. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils and similar materials.

1.12 PROJECT CLOSEOUT

- A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, submit written statement, to the Owner's Representative, that the Project or designated portion of the Project is substantially completed along with a list of items to be completed, if any, and the scheduled completion dates for those items.
 1. The Owner's Representative will confirm the level of completion and, if appropriate, will request the Architect to prepare a Certificate of Substantial Completion with a punchlist of remaining items to be completed.
- B. Closeout Submittals: Before determining date of Substantial Completion, complete the following. List items below that will be incomplete at proposed Date of Substantial Completion.
 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 2. Advise Owner of pending insurance changeover requirements.
 3. Submit specific and general warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
 4. Prepare and submit Project Record Documents, operation and maintenance manuals, Final Completion construction photographs, damage or settlement surveys, property surveys, and similar final record information.
 5. Complete final cleaning requirements, including touchup painting and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- C. Statement of Final Completion: Upon completion of all punchlists, the Contractor shall submit a written statement that:
 1. All aspects of the Contract Documents have been complied with, including submission of specific warranties, certifications, guarantees, and maintenance agreements.
 2. Removal of construction cylinders and keys has been completed and permanent cylinders installed with receipt of key delivery to Owners personnel.
 3. All final cleaning has been completed.
- D. Final Closeout Procedures: Before requesting final inspection, complete the following:
 1. Submit a Final Application for Payment.
 2. Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), reviewed by Architect.
- E. Record Drawings: Maintain and submit one set reproducible prints of Contract Drawings and Shop Drawings that show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
- F. O & M Manuals: Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- G. Warranties: Submit written warranties on request of Architect for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents.
- H. Demonstration and Instruction Training: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 1. Provide instructors experienced in operation and maintenance procedures.
 2. Provide instruction at mutually agreed-on times. Schedule training with Owner, at least seven days' advance notice.

- I. Final Cleaning: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations. Employ experienced workers or professional cleaners for final cleaning, who understand and follow each material manufacturer's cleaning instructions.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes reinforced cast-in-place concrete for the following:
 - 1. Structural concrete footings and foundations.
 - 2. Interior slab-on-grade concrete.
 - 3. Steel reinforcement for cast-in-place concrete.
- B. Related Sections include the following:
 - 1. Section 03 47 00 for "Site-Cast Tilt-panel Concrete" for concrete tilt-panels.
 - 2. Section 04 22 00 for "Unit Masonry" for grouting of masonry walls.
 - 3. Section 07 26 26 for "Vapor Barriers" for under slab-on-grade sheet membranes.
 - 4. Section 32 13 13 for "Site Concrete Paving" for exterior concrete pavement and walks.

1.02 SLAB-ON-GRADE PERFORMANCE REQUIREMENTS

- A. Floor Flatness: Unless otherwise noted on drawings, all interior slabs-on-grade shall be constructed to an overall FF 50/FL 35 with a minimum local value of FF 35/FL 25. The overall area is a Test Section as defined in ASTM E 1155. The minimum local area is the area of a single placement.
- B. Floor Sealing: Interior slabs-on-grade indicated to receive applied densifier/sealer and prior to the start and application of products, the concrete subcontractor shall construct a test slab using the same equipment, tools and methods for finishing and curing the test slab as will be used for the remaining interior floor slab. Remaining application of densifier/sealer and polishing methods shall not commence until the owner has accepted the interior floor test slab.
- C. General Structural Requirements: Where more restrictive requirements are indicated on the Contract Drawings, these requirements shall supersede the requirements of this Section.

1.03 SUBMITTALS

- A. Product Data: For each type of manufactured material and proprietary product; including admixtures, curing compounds, patching compounds, and other materials to be installed in the Work.
- B. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing and arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance with requirements indicated, based on comprehensive testing of proposed materials.
- D. Welding Certificates: Copies of certificates for welding procedures and personnel.
- E. Design Mixes: Submit mix designs at least three weeks prior to placement, for each type and class of concrete, in accordance with ACI 318 and ACI 302. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances that warrant adjustments.
 - 1. Include test results that indicate admixtures, slump, shrinkage, fly-ash proportions and compressive strength.
 - 2. Include aggregate gradation test reports for each mix design.

- F. Certificates of Compliance: Signed by manufacturers certifying that each of the following items complies with requirements:
1. Cementitious materials, admixtures, recycled materials and aggregates.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete 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.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment and certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
- C. Testing Agency Qualifications: An independent testing agency, engaged by the Owner, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated. Retesting of rejected or nonconforming work and materials shall be at Contractor's expense.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code-- Reinforcing Steel."
- F. Codes and Standards: Comply with applicable provisions of the following codes, specifications and standards, unless more stringent provisions are indicated or specified:
1. 2021 International Building Code.
 2. ACI 301, "Specification for Structural Concrete."
 3. ACI 302.1R, "Guide for Concrete Floor and Slab Construction".
 4. ACI 306R, "Guide to Cold Weather Concreting."
 5. ACI 305R, "Guide to Hot Weather Concreting."
 6. ACI 318, "Building Code Requirements for Structural Concrete".
 7. ASTM A 1094, "Standard Specification for Continuous Hot-Dip Galvanized Steel Bars for Concrete Reinforcement."
 8. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 9. ASTM C 39, "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens".
 10. ASTM C 42, "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Concrete".
 11. ASTM C 143, "Standard Test Method for Slump of Hydraulic Concrete".
 12. ASTM C 172, "Standard Practice for Sampling Freshly Mixed Concrete".
 13. ASTM C 173, "Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method".
 14. ASTM C 231, "Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method".
 15. ASTM C 618, "Specifications for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete".
 16. ASTM E 1155, "Standard Test Method for Determining Floor Flatness and Levelness Using the F-Number System".
 17. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice".

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 practical sizes to minimize number of joints.
 - 1. Exterior-grade plywood panels, rosin-coated plywood, metal, or other approved panel materials.
- B. Rough-Formed Finished Concrete (below-grade only): Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Pole-Base Supports: Metal, glass-fiber-reinforced plastic, or paper-fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient thickness to resist wet concrete load deformation.
- D. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off non-corrosive metal or reinforced plastic form ties designed to prevent form deflection and to prevent spalling of concrete on removal.
- E. Chamfer Strips: Solid wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum. Strips cut from wood sheet material are not acceptable.
- F. Form-Release Agent: Commercially formulated compound with a maximum VOC content of 350 g/L, that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces or finishing operations.

2.02 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed, plain finish.
- B. Low-Alloy-Steel Welded Bars; ASTM A 706, Grade 60, deformed, plain finish.
- C. Plain-Steel Welded Wire Fabric: ASTM A 1064, fabricated from as-drawn steel wire into flat sheets.
- D. Galvanized Plain-Steel Welded Wire Fabric: ASTM A 1064, fabricated from steel wire into flat sheets.
- E. Deformed-Steel Welded Wire Fabric: ASTM A 1064, flat sheet.
- F. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.03 REINFORCEMENT ACCESSORIES

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing and supporting reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast 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 or CRSI Class 2 stainless-steel bar supports.
 - 2. For slabs-on-grade, use supports with sand-plates where base material or vapor-barrier membrane will not support chair legs.
- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615, Grade 60.
- C. Dowel Baskets: In accordance with ACI 302.1R-04. Acceptable manufacturers include:
 - a. Double-Tapered Basket; Green Streak Group, Inc.
 - b. PD3 Basket; PNA Construction Technologies.

2.04 CONCRETE MATERIALS

- A. Portland Cement:

1. Concrete which is not exposed to soils with severe sulfate content: ASTM C 150, Type I or Type II, alkali content not to exceed 0.6 percent.
 2. Concrete which is exposed to soils with severe sulfate content: ASTM C 150, Type V.
 3. Single-Source: Provide cementitious material of the same brand from the same manufacturer's plant for all cast-in-place concrete throughout the Project.
- B. Fly Ash: ASTM C 618, Class C, proportioned in accordance with ACI 232-4.1, meeting the following:
1. Conform to the requirements of the current edition of ASTM C 618 , as follows:
 - a. ASTM C 618, Table 1 Chemical Requirements and Table 1A Supplementary Optional Chemical Requirements.
 - b. ASTM C 618, Table 2 Physical Requirements and Table 2A Supplementary Optional Physical Requirements in the following areas:
 - 1) Effectiveness in Controlling Alkali-Silica Reaction.
 - 2) Effectiveness in Contributing to Sulfate Resistance, Procedure A.
 2. Combined fly ash, silica fume or other pozzolans shall not exceed the following percentages of cement by weight and have a replacement factor of 1.2 relative to cement replaced unless approved otherwise by Structural Engineer of Record:
 - a. Class A Concrete: 20 percent.
 - b. Class B Concrete: Not permitted.
 - c. Class C Concrete: 15 percent.
 - d. Class D Concrete: 25 percent.
- C. Normal-Weight Aggregate: ASTM C 33, uniformly graded, not less than Class 1N coarse aggregate, free of substances with deleterious reactivity to alkali in cement. Provide aggregates from a single source for Class B and Class C concrete mixes.
1. Nominal Maximum Course Aggregate Size: 1 1/2 inches, 3-sided angular.
 2. Fine Aggregate: Clean, washed, sand and gravel, from same source as course aggregate.
- D. Water: Potable.

2.05 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by a qualified independent testing agency for preparing and reporting proposed mix designs by either laboratory trial mix basis or field test data basis, as follows:
1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- B. Structural Concrete: Proportion mix designs to produce strength(s) as noted on Drawings, with the following properties:
1. Class A: Normal weight concrete; for use in walls, columns, suspended slabs and all concrete except as noted below.
 - a. Minimum compressive strength (28 Days): 4000 psi.
 - b. Maximum coarse aggregate size: 1 inch.
 - c. Maximum water percentage to cementitious materials ratio by weight: 0.50.
 - d. Maximum slump: 4 inches.
 2. Class B: Normal weight concrete; for use in concrete exposed to weather
 - a. Minimum compressive strength (28 Days): 4000 psi.
 - b. Maximum coarse aggregate size: 1 inch.
 - c. Maximum water percentage to cementitious materials ratio by weight: 0.50.
 - d. Maximum slump: 5 inches.
 3. Class C: Normal weight concrete; for use in interior slabs-on-grade.
 - a. Minimum compressive strength (28 Days): 4000 psi.
 - b. Maximum coarse aggregate size: 1-1/2 inch.
 - c. Maximum water percentage to cementitious materials ratio by weight: 0.48.
 - d. Maximum slump: 5 inches.
 4. Class D: Normal weight concrete; for use in footings and foundations.
 - a. Minimum compressive strength (28 Days): 3000 psi.
 - b. Maximum coarse aggregate size: 1-1/2 inch.
 - c. Maximum water percentage to cementitious materials ratio by weight: 0.52.
 - d. Maximum slump: 6 inches.

- C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by General Contractor when characteristics of materials, job conditions, weather, test results or other circumstances warrant; at no additional cost to Owner and as accepted by Owner. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Owner before using in Work. Both the concrete supplier and the concrete subcontractor shall guarantee that the proposed concrete mix design will produce a concrete which will meet the specifications for this Project.
 - 1. Contractor shall verify that the workability, finishability and setting times are appropriate for slab installations.
 - 2. Placement shall be made by chute directly from the concrete trucks. If pumping of the concrete is contemplated for any special locations, the proportions established above shall not be altered to suit the capabilities of the pumping equipment.

2.06 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and ASTM C 1116, and furnish batch ticket information.
 - 1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
 - 2. For dry-batch deliveries, ensure a minimum of 100 mixer-barrel revolutions, during transportation from central plant to site.
- B. Provide batch ticket for each batch discharged and used in the work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water added. The batch ticket shall state the quantity of water or ice that may be added on the job site, if any.

2.07 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and compatible with other admixtures and cementitious materials. Do not use admixtures containing fly ash or slag.
- B. Water-Reducing Admixture: ASTM C 494, Type A or Type F (mid-range water reducer).
- C. Water-Reducing and Retarding Admixture: ASTM C 494, Type A or Type D.
- D. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494, Type A or Type F.

2.08 FLOOR AND SLAB TREATMENTS

- A. Penetrating Liquid Densifier/Sealer Floor Treatment: Chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces. Minimum 20% solids content. Apply on warehouse floor slabs only. Acceptable products include:
 - 1. Ashford Formula; Curecrete Chemical Co., Inc.
 - 2. Euco Diamond Hard; Euclid Chemical Co.
 - 3. Seal Hard; L&M Construction Chemicals, Inc.

2.09 CURING MATERIALS

- A. Flooring Compatibility: Obtain written documentation from flooring contractor(s) that curing compound is compatible with flooring materials and adhesives that will be applied to floor surfaces prior to delivery of curing compound to jobsite.
 - 1. Do not use where slabs are scheduled to receive penetrating sealer/hardener or thin-set tile applications.
- B. Liquid-Membrane Curing Compound: Clear, water-based, self-dissipating V.O.C. compliant, resin-based type: ASTM C 309, Type 1, Class B. Acceptable products include:
 - 1. Vocomp 20; W. R. Meadows, Inc.

2. Kurez DR VOX; Euclid Chemical Company.
 3. L&M Cure R; L&M Construction Chemicals, Inc.
- C. Liquid-Membrane Curing and Sealing Compound: Clear, water-based, acrylic copolymer type: ASTM C 1315, Type 1, Class A or Class B, 25% solids content. Acceptable products include:
1. Vocomp 25; W. R. Meadows, Inc.
 2. Super Aqua Cure VOX; Euclid Chemical Company.
 3. Dress & Seal WB 25; L&M Construction Chemicals, Inc.
 4. Atlas Quantum-Cure; Atlas Tech Products
- D. Evaporation Reducer: Spray-applied, waterborne, monomolecular film forming, for application to fresh concrete to aid in the prevention of rapid moisture loss during the finishing operations. Acceptable products include:
1. EucoBar; Euclid Chemical Company.
 2. E-CON; L&M Construction Chemicals, Inc.
 3. Confilm-MasterKure ER 50; BASF Construction Chemicals.

2.10 RELATED MATERIALS

- A. Vapor Barrier: Provide vapor barrier membrane in accordance with Section 07 26 26 "Under-Slab Vapor Barriers", under floor slab areas to receive floor coverings or otherwise indicated on Drawings. Polyethylene sheet film shall not be permitted under interior slabs.
- B. Joint-Filler Strips: At slabs abutting vertical elements, ASTM D 1751, cellulosic-foam; 1/2-inch thick. Acceptable Products include:
1. Ceramar; W. R. Meadows, Inc.
 2. Normaflex; Nomaco.
- C. Reglet Keys: Fabricate reglets of not less than 0.0217-inch- thick galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- D. Semi-Rigid Joint Filler: Two-component, semi-rigid, 100 percent solids, polyurethane resin with a minimum Shore "A" hardness of 90 per ASTM D 2240. Acceptable Products include:
1. Edge-Pro 90; Metzger McGuire, Inc.
 2. Qwickjoint UVR 95; Euclid Chemical Company.
 3. MasterSeal CR 100; BASF Company.
- E. 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 to suit requirements, and as follows:
1. Types I and II, non-load bearing, for bonding freshly hardened concrete to hardened concrete.
- F. Non-Shrink Grout: ASTM C 1107, Grade B, 7,000 psi, pre-packaged, non-metallic, non-staining, non-shrink grout. Acceptable products include:
1. Euco N-S Grout; Euclid Chemical Company.
 2. Masterflow 555; BASF Construction Chemicals.
 3. SikaGrout; Sika Corporation, Inc.
- G. Self-Leveling Underlayment: ASTM C 109, 4,000 psi, cementitious copolymer, compatible with floor sealers. Acceptable products include:
1. Flo-Top; Euclid Chemical Company.
 2. Ardex K-15 Self-Leveling Underlayment; Ardex Engineered Cements.
 3. Levelayer I; Dayton Superior Corporation.

2.11 REPAIR MATERIALS

- A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene. Combine 1 part portland cement to 1-1/2 parts fine sand in a 50:50 mixture with admixture to a thick paste consistency.

- B. Crack Repair Filler: Two-component, low-viscosity, epoxy urethane resin with a minimum compressive strength of 8000 psi per ASTM D 695. Acceptable Products include:
 - 1. Sikadur 35; Sika Corporation, Inc.
- C. Tilt-Panel Formboard Fastener Filler: See Section 03 47 00 – Site-cast Tilt-Panel Concrete for slab-on-grade patching materials related to tilt-panel formboard casting.
- D. Patching Mortar: Dry-pack mix consisting of polymerized portland cement and fine aggregate passing No. 16 sieve, using only enough water for handling and placing. Acceptable products include:
 - 1. Thorite 400; BASF Construction Chemicals, LLC.
 - 2. Patchcrete; Lyons Manufacturing, Inc.
 - 3. Ardex CP; Ardex Engineered Cements.

PART 3 - EXECUTION

3.01 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, dynamic loads, and construction loads that may be applied, until concrete structure can support such loads.
- B. Chamfer exterior corners and edges of permanently exposed concrete.
- C. Form openings, chases, offsets, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- D. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- E. Form Liners: Where special cast-in-place wall finishes are indicated to be produced from form liners, securely place form liner panels in pattern indicated, aligning ribs or pattern of end panels tightly and uniformly to reduce the appearance of panel joints or mortar leakage.
- F. 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.

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 approved Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.03 SLAB-ON-GRADE PREPARATION

- A. Coordinate electrical and plumbing work to insure all under-slab sleeves, anchors, conduit, floor boxes, pipes, fittings and other items are installed to correct location, elevation and slope.
- B. Install crushed stone sub-base to the minimum compacted thickness as indicated on Drawings. Prior to installation, verify proper sub-grade elevations to assure that the minimum thickness of stone sub-base can be achieved.
- C. Compact sub-grade, sub-base and pipe trench areas to minimum 95% Modified Proctor density in accordance with ASTM D 1557.

3.04 VAPOR BARRIERS

- A. General: Place vapor barrier membrane in accordance with Section 07 26 26 for "Vapor Barriers" for under slab-on-grade vapor barrier membranes.
 - 1. Lap and seal seams and penetrations as recommended by membrane manufacturer.
 - 2. Do not cover membrane with sand cushion. Concrete shall be placed directly in contact with membrane.

3.05 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
 - 1. Where vapor barriers are required, do not cut or puncture vapor barrier. Repair damage and reseal vapor barrier in a manner acceptable to membrane manufacturer before placing concrete.
 - 2. Install all anchors, ties, chairs and other supports as requested to insure reinforcing being held at proper locations. All reinforcing shall be wired in place using annealed wire. Wood or clay brick chairs are not be acceptable.
 - 3. Welded wire fabric mesh shall be lapped a minimum of 6 inches at side laps and secured with tie wires no more than 4 feet on center.
- B. Clean reinforcement of loose rust and mill scale and other foreign materials.
- C. Accurately position, support, and securely tie reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
- D. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Tie overlaps with wire.

3.06 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete. Where special floor finishes, such as ceramic tile or terrazzo, require alignment of flooring joints with concrete joints, coordinate location of concrete joints with approved flooring layout submittals.
- B. Construction (Cold) Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Space joints and continue reinforcement across construction joints and closure pours as indicated. Do not continue reinforcement through sides of column isolation closure pours, unless specifically indicated otherwise.
 - 2. Locate slab-on-grade construction joints to align with column grid lines or around largest single slab pour whichever is less. Form slab edges to provide 1/2-inch wide joint, full depth of slab.
 - 3. Space vertical joints in cast-in-place walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- C. Contraction (Control) Joints in Floor Slabs: Form weakened-plane contraction joints, sectioning concrete into areas as indicated or no greater than 15 feet apart in any direction. Construct contraction joints as follows:
 - 1. Sawed Joints: Form contraction joints with power saws equipped with a "Soff-Cut" diamond blade and skid plate. Joints shall be cut as soon as the slab will support the weight of the saw and operator and when cutting action will not tear, abrade, or otherwise damage the concrete surface. Cuts must be made before concrete develops random contraction cracks and no later than four (4) hours after completion of finishing operations.
 - 2. Cut 1/8-inch wide joints, cutting a minimum of 1-1/2" inch deep or one-third of concrete slab thickness (whichever is deeper) into interior floor slab. Chalk lines and concrete dust shall be removed completely and immediately after cutting operation.
- D. Isolation Joints in Floor Slabs: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as 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. Wall-to-Slab Joints: Where floor slabs abut vertical wall elements, provide 1/2-inch wide expansion joint of depth suitable for placement of sealant.
- E. Dowel Joints: Install dowel sleeves and dowels or dowel-bar basket assemblies at joints where indicated. Use dowel sleeves to prevent concrete bonding to one side of joint.

3.07 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete, securely braced and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Testing Laboratory.
- C. Deposit vertical concrete in forms in horizontal lifts in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
- 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.
- E. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
 1. Cool ingredients before mixing to 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.

3.08 FINISHING FORMED VERTICAL SURFACES

- A. Rough-Formed Finish: As-cast concrete surface texture imparted by approved form materials, with tie-holes and honeycomb areas repaired and patched level with surface, and fins and protrusions exceeding 1/8 inch in height sanded flush. Provide on vertical formed concrete surfaces not exposed to view in the finished Work or concealed by other construction or finish materials.
- B. Smooth-Formed Finish: As-cast concrete finish imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Provide finish on all interior and exterior vertical formed cast-in-place concrete surfaces exposed to view or to be covered with thin-veneer coatings applied directly to concrete surface such as EIFS top-coats, paint or textured paint coatings and liquid-waterproofing membrane coatings. Repair and fill defective concrete surfaces and patch level with adjacent surface with fins and protrusions ground flush.
- C. Grout-Rubbed Finish: Where indicated on Drawings, provide grout-rubbed finish on concrete surfaces that receive smooth-formed finish, except do not apply grout-rubbed finish to integral-color concrete surfaces or surfaces scheduled to receive exposed aggregate finish.
 1. Combine 1 part portland cement to 1 part fine sand in a 50:50 mixture with acrylic bonding admixture and water to a stiff grout consistency. Blend standard portland cement with white portland cement in trial applications until dry grout matches adjacent surface finish and color.
 2. Dampen concrete surface, apply grout to coat surface and fill pin-holes. Remove excess grout by scrapping and rubbing with rubber float to feather and blend to a uniform finish and texture. Keep surface damp for at least 36 hours after final rub finishing.
- D. Curbs and Equipment Pads: Remove forms while concrete is still wet but stiff enough to support weight without deformation. Steel-trowel vertical surface edges to a hard, dense finish with corners tooled to

slightly round profile. Where broom finish is indicated on slab finish, apply same finish techniques to vertical surfaces to match final slab finish.

3.09 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraighening, and finishing operations for concrete surfaces and as necessary to meet the FF and FL requirements. A minimum of one (1) finisher or finishing supervisor shall be a certified ACI Flatwork Finishing Technician and shall be present during all slab finishing operations.
 - 1. Use laser screeds, vibratory screeds, 10-foot highway straightedges and bull floats to initiate screeding and floating process to form a uniform and open-textured surface plane before excess moisture or bleed water appears on the surface.
 - 2. Remove excess water before starting floating operations.
 - 3. Do not further disturb surfaces before starting finishing operations. Do not wet concrete surfaces during finishing operations.
- B. Interior Floor Slab Tolerances:
 - 1. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials." Interior slab-on-grade concrete floors shall be constructed as follows:
 - a. Warehouse Areas (Class 6 – Random Traffic):
 - 1) Specified Overall Value (SOV): FF 50/FL 35
 - 2) Minimum Local Value (MLV): FF 35/FL 25 .
 - 2. Slabs shall be measured in accordance with ASTM E 1155 within 48 hours after casting. The overall area is a Test Section as defined in ASTM E 1155. The minimum local area is the area of a single placement. Additional slabs shall not be cast until an Owner's representative has accepted the measurements from the previous pours.
 - 3. Acceptance of floor slabs for flatness and levelness:
 - a. Owner's testing agency will conduct flatness and levelness testing.
 - b. In the event that FF or FL for a placement is below the minimum local value, the contractor, at the direction of the Owner's representative, will do one of the following:
 - 1) Remove and replace the slab.
 - 2) Rebate to the Owner an amount as defined in the Contract.
 - c. In the event that the combined flatness or levelness for the entire test surface is below the overall specified value, the Contractor shall rebate to the Owner as defined in the Contract.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Cut down high spots, and fill low spots. Repeat float passes until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces indicated and to floor and slab surfaces to be covered with thick-set tile.
- D. Hard Steel-Troweled Finish: Continue highway straightedge floating operations until specified floor tolerances are achieved.
 - 1. Finish surfaces with power-operated troweling machine with adjustable Teflon-coated steel trowel blades not less than 45" in diameter. Hard trowel surface a minimum of three (3) trowelings, producing an acceptable smooth surface. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance. Care shall be taken not to overwork the surface.
 - 2. Apply steel-trowel finish to all floor slab surfaces unless otherwise indicated.
- E. Trowel and Broom Finish: Where scheduled to receive thin-set tile applications, apply trowel finish and immediately follow with light-broom finish to slightly scarify surface to accept thin-set mortar or adhesives.
- F. Non-Slip Broom finish: Apply a medium-broom finish to exterior walks, stoops and platforms, unless otherwise indicated. Remove edge-tool marks at control joints by lightly brooming after final contour of joint profile is achieved.

3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings, greater than 1/4 inch in diameter, left in concrete exposed to view, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction.

3.11 INTERIOR CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive hot temperatures. Comply with recommendations in ACI 305R for hot-weather protection during curing.
 - 1. Protect interior slabs from excessive moisture loss before and during finishing operations with evaporation-retarding materials, applied beforehand or power troweling. Apply retarder to maintain moist surface conditions and to minimize plastic dry shrinkage cracking of the concrete surface of freshly placed concrete in accordance with manufacturer's instructions per Article 2.09, Section E.
- B. Interior Slabs (sheet membrane cure): All interior slabs shall be cured for a period of five (5) days using a moisture-retaining cover. Apply moisture-retaining cover to interior floor slab within six (6) hours after finishing operations. Moisture-retaining cover shall be kept wet and in contact against the floor during entire five-day cycle.
 - 1. Provide hold-downs and waterproof seam tape to maintain cover contact with surface of slab.
 - 2. Remove moisture-retaining cover and immediately scrub the entire area with auto-scrubber and interior concrete floor cleaning solution.
 - 3. After interior concrete slab is thoroughly cleaned of all salts, laitance, dirt and debris, allow interior concrete slab to air dry for at least twelve (12) hours prior to applying liquid densifier/sealers.
- C. Interior Slabs (dissipating membrane cure): At Contractor's option, interior concrete slabs shall be cured using a reduced odor, dissipating liquid membrane forming curing compound that is formulated from hydrocarbon resins. The dissipating liquid membrane forming curing compound shall meet the requirements of ASTM C-309 with a maximum V.O.C. content of 450g/l.
 - 1. Do not apply where slabs are scheduled to receive floor finishes.
 - 2. Apply curing compound the same day of concrete pour and after final finishing operations have been completed, including saw-cutting of control joints.
 - 3. Spray-apply at a minimum rate of 400 s.f. per gallon and lightly broom material into surface of concrete. Apply curing compound prior to any other chemical treatment of concrete surface.
 - 4. Curing compound shall be completely removed from the interior concrete floor slab. Allow interior concrete slabs to air dry for at least twelve (12) hours prior to applying liquid densifier/sealers.
 - 5. The cost associated with the removal of dissipating liquid membrane forming curing compound from the interior concrete floor slab shall be the responsibility of the Contractor.
- D. Formed Surfaces: For formed, vertical concrete and suspended slabs, keep forms in place for 7 days. Where removal of forms are required before 7-day cure period, cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces with fog-spray application of water for remaining cure period.

3.12 LIQUID DENSIFIER/SEALER APPLICATION

- A. General: Apply liquid densifier/sealer to all interior slab-on-grade concrete slabs. If the liquid densifier/sealer is to be applied as a curing compound within 24 hours of concrete finishing or saw-cutting operations, consult liquid densifier/sealer manufacturer for application procedures. Coordinate application of any tilt-panel bondbreaker compounds with liquid densifier/sealer manufacturer so as not to compromise the penetration of the liquid densifier/sealer into the concrete slab.
- B. Floor Slab Cleaning: Prior to application of liquid densifier/sealer, inspect and thoroughly clean slab with auto scrubber to ensure that it is clean and free of curing or sealing compounds, tilt-panel bondbreakers, dust, oils or other contaminants that might inhibit the proper application and penetration of the liquid densifier/sealer.
 - 1. Scrape the floor using a scraper as required to remove remaining saw-cut residue, form glue, texture overspray, oil drippings, and other built-up material on the surface. Use a non-acidic cleaner compatible with the liquid densifier/sealer.

2. Scrub the entire floor with an automatic scrubber capable of a minimum of 80 psi water pressure, equipped with a combination or light grit rotary brushes and a neutral pH cleaning detergent that is compatible with the liquid densifier/sealer. Remove liquid as the floor is scrubbed.
 3. Immediately following cleaning process, allow floor slab to air-dry for twelve (12) hours, prior to applying the first application of liquid densifier/sealer.
- C. Application: Application of liquid densifier/sealer shall be performed by an approved applicator of the liquid densifier/sealer manufacturer. The approved applicator for the initial application shall be the same as for the polishing process and any additional application of liquid densifier/sealer in accordance with manufacturer's instructions.
1. Within twenty-four hours after air-dry period, apply liquid densifier/sealer with low-pressure sprayer or squeegee at a minimum coverage rate 200 sq. ft. per gallon keeping the slab surface wet for a minimum of 30 minutes. Work the material into the slab surface with a soft-bristle broom or auto-scrubber.
 2. In hot-weather conditions, should areas become dry during 30 minute soak-in period, apply additional liquid densifier/sealer to maintain a wet surface for the full soak-in period.
 3. After the liquid densifier/sealer has been absorbed into the slab surface, flush all finished surfaces with water and broom or squeegee excess liquid densifier/sealer material, completely removing excess material from slab surfaces.
 4. Mechanically remove excess liquid densifier/sealer that has been allowed to dry. Consult liquid densifier/sealer manufacturer for removal procedures.
- D. Second Application: The polishing process and additional application of liquid densifier/sealer shall take place as late in the project sequence as practical, but prior to construction completion.
1. Liquid Densifier/Sealer: Provide a second application of liquid penetrating/sealer at a minimum coverage 1000 sq. ft. per gallon. Buff floor surface with one pass of buffing pads to provide a hard polish appearance, to attain an average gloss reading of not less than 30. Completely clean floor of any remaining residue.

3.13 JOINT FILLERS

- A. Joint Filler Installation: Comply with recommendations in ACI 302 for use of joint fillers as applicable to materials, applications, and conditions indicated in accordance with manufacturer's instructions per Article 2.10, Section D. Install joint filler as late in the project sequence as practical, but no sooner than 90 days after slab pour.
1. Cleaning: The joint must be clean and dry. All oil, dirt, debris, paint, and any other material that may be a bond breaker must be removed from the joint surfaces, prior to joint filler application.
 2. Mixing: The specified joint filler is a two part product requiring machine mixing and placing. Premix Part A and B separately before using. Follow pump manufacturer's equipment instructions.
 3. Placement: Joint filler shall be placed full depth. No backer rod is allowed. Joints should be overfilled and shaved even with the surrounding joint edge giving the floor joints a flat, smooth appearance. Shaving of excess joint filler can occur approximately 30 minutes after filling of joints.
 4. Depth of Joint Filler (Sawcuts): For proper load transfer, joints must be filled full depth to bottom of sawcut, but in no case shall the joint filler be any less than 1-1/4" deep in the joint.
 5. Depth of Joint Filler (Construction Joints): At construction joints, backer rod shall be permissible, but shall be placed a minimum depth of 1 1/2" below finished floor.
- B. Random Testing: The testing agency shall take a minimum of 10 random tests of the joint filler material per 20,000 sq. ft. of slab area, to ensure that no backer rod is installed at sawcuts.

3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas. Where finished surface of concrete is intended to be left exposed, use methods pre-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, repair defects on surfaces exposed to view, by cutting out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete but not less than 1 inch in depth. 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.
- D. Repairing Slab-on Grade 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, pop-outs, 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 low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 - 4. Apply leveling agent to correct unsatisfactory floor surfaces where slab finish tolerances are beyond specified limits.
- E. Perform structural repairs of concrete subject to Structural Engineer's approval.
- F. Apply leveling agent to correct unsatisfactory floor surfaces where slab finish tolerances are beyond specified limits.
 - 1. Apply material as necessary to provide an acceptable surface for flooring contractor.
 - 2. Application to be in accordance with Manufacturer's directions.

3.15 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article. An ACI Field Grade 1 Certified technician shall cast all test cylinders and perform all slump cone tests.
- B. Testing Services: 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 (four cylinders) for each day's pour of each concrete mix exceeding 10 cu. yd. One set of test cylinders may represent no more than 50 cubic yards of concrete or one day's pour
 - 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each concrete mix on each truck delivery load. Concrete used for slump cone test shall not be taken from first or last 15% of each load. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 - 4. Compressive-Strength Tests: ASTM C 39 as follows:
 - a. Test two field-cured specimens at 7 days and two at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

- C. Strength of each concrete mix will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Structural Inspector, 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 mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- E. 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 or by other methods as directed by Architect.

END OF SECTION

SECTION 03 47 00

SITE-CAST TILT-PANEL CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes load-bearing, site-cast concrete, including the following:
 - 1. Monolithic tilt-up concrete panels.
- B. Related Sections include the following:
 - 1. Section 03 30 00 for "Cast-in-Place Concrete" for slab-on-grade closure strips, slab finishes and sealers and general concrete construction.
 - 2. Section 05 50 00 for "Metal Fabrications" for cast-in steel embeds.
 - 3. Section 07 92 00 for "Joint Sealants" for elastomeric joint sealants between tilt-up panels.
 - 4. Section 09 91 16 for "Painting" for field painting of tilt-panels.

1.02 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments. Provide historical test data in accordance with ACI-301 with a minimum of 20 test breaks.
- C. Shop Drawings: Detail fabrication and installation of tilt-up site-cast concrete units. Indicate panel locations, plans, elevations, dimensions, shapes, cross sections, and details of steel embedments.
 - 1. Include steel reinforcement, detailing fabrication, bending, and placing. Include material, grade, bar schedules, stirrup spacing, bent-bar diagrams, arrangement, and supports of concrete reinforcement. Include additional steel reinforcement to withstand hoisting and erection stresses.
 - 2. Include locations and details of embeds, cross-referenced to structural details.
 - 3. Include locations and details of reveals, panel edges and related architectural features.
 - 4. Indicate welded connections by AWS standard symbols. Detail cast-in inserts, connections, and joints, including accessories.
- D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:
 - 1. Cementitious materials, admixtures and aggregates.
 - 2. Steel reinforcement.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer with a minimum of 3 years documented experience with tilt-up site-cast concrete similar in material, design, and extent to that indicated for this Project.
- B. Concrete Manufacturer Qualifications: A firm complying with ASTM C 94 requirements for production facilities and equipment.
 - 1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency: An independent testing agency, engaged by Owner will conduct the testing indicated, as documented according to ASTM E 548.

- D. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering analysis for the design and hoisting of tilt-panels of the size indicated.
- E. Source Limitations: Obtain each type or class of cementitious material from the same manufacturer's plant, each aggregate from the same source, and each admixture from the same manufacturer.
- F. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- G. Codes and Standards: Comply with applicable provisions of the following codes, specifications and standards, unless more stringent provisions are indicated or specified:
 - 1. 2021 International Building Code.
 - 2. ACI 301, "Specification for Structural Concrete."
 - 3. ACI 302.1R, "Guide for Concrete Floor and Slab Construction".
 - 4. ACI 318, "Building Code Requirements for Reinforced Concrete".
 - 5. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 6. ACI 551R-05, "Tilt-Up Concrete Structures".
 - 7. ACI 551.2R-10, "Design Guide for Tilt-Up Concrete Panels".
 - 8. ASTM C618, "Specifications for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete".
 - 9. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice".
- H. **Formliner Mock-up:** After approval of form liner products made under Product Data Submittals, form a 5' x 5' mockup to verify selections made and to demonstrate aesthetic effects and qualities of materials and execution.
 - 1. Build a mockup of each type of form liner installation.
- I. Pre-Installation Conference: Prior to erection of panels, conduct conference at Project site and submit meeting minutes, describing bracing, methods, means and sequencing of panel erection and crane access.

PART 2 - PRODUCTS

2.01 FORMS AND ACCESSORIES

- A. Side Forms: Metal, mini-lam dressed lumber, or other approved materials that are non-reactive with concrete and that will provide continuous, true, and smooth concrete surfaces.
- B. Chamfer or Reveal Strips: Smooth finish MDO wood, metal, PVC, or rubber strips, with sides beveled. Cut plywood, OSB, MDF and similar wood sheet materials are prohibited for use as reveals strips.
 - 1. Perimeter Panel Edge Chamfer Profile: 3/4 inch by 3/4 inch, with 45 degree bevel.
 - 2. Reveal Strip Profile: 1/2 inch deep, with 22 1/2 degree side-draft bevel, widths as indicated.
- C. Form Liner: The design of seamless, continuous length, rigid ABS plastic form liners are based on products listed. Subject to compliance with requirements, provide the named product or a comparable product to the following:
 - 1. Form Liner No. 14348; VinylLok Fitzgerald Formliners
 - 2. Reveal Pattern: Smooth-finish, fluted-rib, 3/4" deep, 2 1/2 "o.c. rib spacing.

2.02 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Welded-Steel Reinforcing Bars: ASTM A 706, Grade 60, deformed.
- C. Plain-Steel Wire: ASTM A 82, galvanized.

- D. Plain-Steel, Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- E. Deformed-Steel, Welded Wire Fabric: ASTM A 497, flat sheet.
- F. Bar Supports: Manufacture of plastic or CRSI Class 1 plastic-protected galvanized steel wire or Class 2 stainless-steel wire.

2.03 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type 1 or Type II, alkali content not exceeding 0.6 percent.
- B. Normal-Weight Aggregate: ASTM C 33, uniformly graded from a single source, nominal maximum aggregate size of 3/4 inch.
- C. Water: Potable and complying with ASTM C 94.
- D. Admixtures: Certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
 - 1. Concrete containing plasticizing admixtures shall have field-verified maximum slump of 3 inches prior to adding admixtures and 7 inches maximum slump at point of placement. Admixtures shall be approved by Structural Engineer prior to delivery of concrete.
- E. Fly Ash: ASTM C 618, Class C or F, proportioned in accordance with ACI 232-4.1, meeting the following:
 - 1. Conform to the requirements of the current edition of ASTM C 618, as follows:
 - a. ASTM C 618, Table 2 Physical Requirements and Table 2A Supplementary Optional Physical Requirements in the following areas:
 - 1) Effectiveness in Controlling Alkali-Silica Reaction.
 - 2) Effectiveness in Contributing to Sulfate Resistance, Procedure A.

2.04 BONDBREAKERS

- A. Waterborne, Chemically-Reactive Bondbreaker: ASTM C 309, Type 1, self-dissipating polymerized emulsion containing no oils, waxes, paraffins, or silicones, compatible with ground slab curing compounds and floor sealer/densifier applications.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to the following:
 - a. Silcoseal Select; Nox-crete Products Group.
 - b. Sure Lift J6WB; Dayton Superior Corp.
 - c. Starseal EZ Lift; Vexicon Chemicals.

2.05 CURING MATERIALS

- A. Moisture-Retaining Cover: ASTM C 171, polyethylene film sheet.
- B. Curing and Sealing Membrane: Clear, self-dissipating, waterborne, membrane-forming curing and sealing compound ASTM C 309, Type 1, Class B. Acceptable products include:
 - 1. Vocomp 20; W. R. Meadows, Inc.
 - 2. Dress & Seal 20; L&M Construction Chemicals, Inc.
 - 3. Kure-N-Seal 20; BASF Construction Chemicals.

2.06 CONNECTION MATERIALS

- A. Carbon-Steel Embedded Plates: ASTM A 36.

- B. Loose Hardware: Furnishing of loose hardware for lifting tilt-up concrete panels by Contractor.
- C. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A, carbon-steel, hex-head bolts and studs; carbon-steel nuts; and flat, unhardened steel washers.
- D. Welded Headed Studs: AWS D1.1, Type B headed studs, cold-finished carbon-steel bars.
- E. Welded-Steel Reinforcing Bars: ASTM A 706, deformed.
- F. Welding Electrodes: Comply with AWS standards.
- G. Hot-Dip Galvanized Finish: Apply zinc coating to steel connections, exposed to the exterior, by hot-dip process complying with ASTM A 123 or ASTM A 153 as applicable.
 - 1. Zinc Repair Paint: ASTM A 780.
- H. Shop-Primed Finish: Prepare surfaces of steel connections, except those surfaces to be embedded in concrete, according to requirements of SSPC-SP 3, and shop-apply primer according to SSPC-PA 1.
 - 1. Primer: Fast-curing, lead-free and chromate-free, modified-alkyd primer complying with performance requirements in FS TT-P-664.

2.07 LIFTING INSERTS AND ACCESSORIES

- A. Furnish inserts, dowels, bolts, nuts, washers, and other items to be cast in panels for tilting and lifting.
- B. Furnish brace anchors and other accessories to be cast in panels and in casting slab for attaching bracing.

2.08 BEARING PADS

- A. Elastomeric Pads: Vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 60 Shore A durometer, minimum tensile strength 2250 psi per ASTM D 412.
- B. Random, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer with a Shore A hardness of 70 to 90 per ASTM D 2240.

2.09 GROUT MATERIALS

- A. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, with minimum water required for placement and hydration.
- B. Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents; capable of developing minimum compressive strength of 5,000 psi in 28 days conforming to CRD-621.

2.10 RELATED MATERIALS

- A. Flashing Reglets: Open type having continuous groove not less than 1-1/8 inches deep by 3/16 inch wide at opening and sloped upward to 45 degrees. Temporarily fill or cover face openings of reglets to prevent intrusion of concrete or debris.
 - 1. Hot-Dip Galvanized Steel Sheet: ASTM A 653, G90 coating, not less than 0.0217 inch thick.

2.11 REPAIR MATERIALS

- A. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene. Combine 1 part portland cement to 1-1/2 parts fine sand in a 50:50 mixture with admixture.
- B. Patching Mortar: Dry-pack mix consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing No. 16 sieve, using only enough water for handling and placing. Acceptable products include:
 - 1. Thorite 400; BASF Construction Chemicals, LLC.
 - 2. Pavcrete; Lyons Manufacturing, Inc.
 - 3. Burke Super Rub; Meadow Burke.
- C. Tilt-Panel Formboard Nail-hole Patching Filler: Two-component, low-viscosity, epoxy urethane resin with a minimum compressive strength of 10,000 psi per ASTM C 881. Acceptable Products include:
 - 1. Sikadur 32; Sika Corporation, Inc.
 - 2. MasterTop 2200; BASF Master Builders Construction Chemicals.

2.12 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mixes or field experience. Proportion normal-weight concrete according to ACI 211.1, ACI 304 and ACI 301.
- B. Normal-Weight Concrete: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 4000 psi, and as indicated on Drawings.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Maximum Slump: 4 inches.
 - 4. Maximum Slump for Concrete Containing High-Range, Water-Reducing Admixture: 7 inches after admixture is added to concrete with 3- to 4-inch slump.
 - 5. Air Content: Add air-entraining admixture at manufacturer's recommended rate to result in concrete at point of placement having an air content of 2 to 4 percent.

2.13 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94. Furnish batch ticket information.
 - 1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 FORMS

- A. Construct and brace edge forms so tilt-up concrete panels are of size, shape, alignment, elevation, and position indicated.
 - 1. Construct forms on slab-on-grade or on temporary casting slab, at Contractor's option.
 - 2. Provide for openings, offsets, recesses, reveals, rustications, reglets, and blockouts.
 - 3. Temporarily fill floor slab joints to provide flush casting surface.
 - 4. Place form liners accurately to provide finished surface texture indicated. Align adjacent form liner seams to maintain uniform pattern, sequence and texture. Coat form liners with form-release agent where form liners will be reused.
- B. Accurately place forms to provide required panel dimensions and tolerances. Kerf wood inserts, such as those forming reglets, rustications, and recesses, for easy removal. Set edge forms for panels to achieve required panel thickness.
- C. Chamfer exposed corners and edges using approved chamfer strips fabricated to produce uniformly straight, smooth lines and tight edge joints.

3.02 BONDBREAKERS

- A. Uniformly and continuously apply a single coat of bondbreaker to casting slab surfaces by power spray or roller according to manufacturer's recommended application rate, before placing steel reinforcement. Recoat areas subjected to moisture before drying. Maintain continuity of coating until concrete placement.

3.03 REINFORCEMENT AND INSERTS

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating and placing reinforcement. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - 1. Field weld reinforcement according to AWS D1.4, where indicated.
 - 2. Do not tack-weld crossing reinforcing bars.
 - 3. Set wire ties so ends are directed into concrete, away from exposed concrete surfaces.
- B. Accurately place and securely support embedded items, anchorages, inserts, cramps, retainers, bar chords and sleeves, and other items to be built into panels.

3.04 PANEL CASTING, GENERAL

- A. Comply with ACI 301 for handling and placing concrete.
 - 1. Place concrete for each panel in one continuous pour. Deposit concrete in a very slow manner with the use of a flat diverter or other means to prevent the dislodging of aggregate or reinforcing.
 - 2. Consolidate concrete to produce smooth finished surfaces free of air pockets and honeycomb.
- B. Maintain position of steel reinforcement, inserts, and anchors during concrete placement, consolidation, and finishing.
- C. Form chamfers at all exterior edges of panel perimeters, and openings, , unless otherwise indicated.
- D. Screed panel surfaces to correct thickness and level with a straightedge and strike off. Begin initial floating before excess moisture or bleed water appears on the surface. Use bull floats or darbies to form a uniform and open-textured surface plane free of humps or hollows. Do not disturb forms or panel surfaces before beginning finishing operations.

3.05 CASTING TOLERANCES

- A. Cast tilt-up concrete panels, measured at the panel over-all face width and height, without exceeding the following tolerances:
 - 1. Height and Width of Panels: As follows:
 - a. Up to 30 Feet : plus 1/8 inch, minus 1/4 inch.
 - b. Each Additional 10 Feet in excess of 30 Feet: plus or minus 1/8 inch.
 - 2. Thickness: plus or minus 1/4 inch.
 - 3. Location and Size of Openings Cast into Panel: plus 1/2 inch, minus 1/4 inch.
 - 4. Skew of Panel or Opening: Difference in length of diagonals of 1/4 inch per 72 inches with a maximum difference of 1/2 inch.
 - 5. Location and Placement Tolerances of Embedded Items: As follows:
 - a. Inserts, Bolts, Pipe Sleeves: 3/8 inch.
 - b. Lifting and Bracing Inserts: 1/2 inch.
 - c. Lateral Placement of Weld Plates: 1 inch.
 - 6. Deviation of Steel Reinforcement Cover: 3/8 inch, maintain 2 inch minimum cover.

3.06 PANEL FINISHES

- A. Provide the following finish to the face-up, interior side, of concrete tilt-panel surfaces:

1. Float Finish: Consolidate surface of plastic concrete with power-driven floats or by hand floating. Restraighten and cut down high spots and fill low spots. Repeat float passes and restraighten until surface is left with a uniform, smooth, granular texture.
 2. Trowel Finish: After applying float finish, apply first trowel finish and consolidate plastic concrete by hand trowel or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and is uniform in texture and appearance.
 3. Final Trowel Finish: After applying first trowel finish, apply a second trowel finish to achieve a flat consistent smooth finish.
- B. Provide the following finish to the face-down, exterior side, of concrete tilt-panel surfaces:
1. Smooth, Floor-slab-cast Finish: Cast panel to produce a surface free of pockets, sand streaks, and honeycombs. Produce a surface appearance of uniform finish and appearance. Fill or repair floor slab joints or imperfections to eliminate reproducing floor imperfections into face of panel finish.
 2. Form Liner Finish: Cast panel over form liners placed, secured, and sealed over casting slab to produce a textured surface free of pockets, streaks, and honeycombs. Produce a surface appearance of uniform pattern and texture.

3.07 CONCRETE PROTECTION AND CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures according to ACI 301.
1. Apply evaporation retarder in hot, dry, and windy weather to protect concrete from rapid moisture loss before and during finishing operations. Apply according to manufacturer's instructions after screeding and bull floating concrete, but before float finishing.
- B. Begin curing immediately after finishing concrete. Cure by one of the following methods:
1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with absorptive cover, water saturated and kept continuously wet.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
 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 during curing period.

3.08 ERECTION

- A. Use erection equipment with care to prevent damage to floor slabs and panels. Lift, support, and erect panels only at designated lifting or supporting points indicated on Shop Drawings.
1. Do not lift panels until at least 75% of specified 28-day compressive strength has been verified.
- B. Install tilt-up concrete panels level, plumb, square, and true. Place panels on leveled grout setting pads or shims in correct position. Maintain 3/4 inch joint width between panels, unless otherwise indicated.
1. Use bearing pads and shim strips to position panels to maintain uniform joint widths. Excessive deviation in joint width between panels from specified tolerances will require repositioning of panels.
- C. Temporarily brace and support panels securely in position to withstand code wind loads that the completed structure was designed to withstand. Maintain braces and supports in place, until entire supporting structure has been completed and permanent connections to panels are secured.
- D. Anchor panels in place and to one another.
1. Weld steel connectors and embedments as indicated, complying with AWS D1.1.
 2. Solidly fill gaps between foundation system and bottom of panels with grout.
- E. Erection Tolerances: Install tilt-up concrete panels without exceeding the following tolerances:

1. Exterior Face Width of Joints: plus or minus 1/4 inch.
2. Vertical Panel Joint Taper: plus or minus 1/4 inch.
3. Alignment of Horizontal and Vertical Joints and Reveals: 1/4 inch.
4. Maximum Offset in Exterior Face of Adjacent Panels: 1/4 inch.
5. Vertical Panel Plumbness: Maximum variation from top to bottom of panel face: 1/2 inch.

3.09 CONCRETE PANEL SURFACE FINISHING AND REPAIRS

- A. Defective Concrete: Repair and patch defective areas to produce a uniformly smooth finish to exterior panel surfaces. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patch holes and voids left by block-outs, erecting and bracing inserts on tilt-up panels and slabs-on-grade. Cut or chip edges of voids perpendicular to concrete surface.
 1. Clean, dampen with water, and brush-coat holes, voids, and block-outs with bonding agent. Fill and compact with patching mortar of a stiff consistency before bonding agent has dried.
 2. Finish surfaces of fills and repairs with same texture and finish as surrounding surfaces.
- C. Exterior-Side Formed Surface Defects: Repair surface defects on surfaces exposed to view that include texture irregularities, cracks, spalls, pin-holes, air bubbles, honeycombs, rock pockets, fins and other projections on the exterior surface, and stains that cannot be removed by cleaning.
 1. Large Surface Defects: Honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete but not less than 1 inch in depth:
 - a. Cut out defects, making edges of cuts perpendicular to concrete surface.
 - b. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
 - c. Fill and compact with patching mortar before bonding agent has dried.
 2. Minor Surface Defects: Pin-holes, air-bubble pockets and honeycomb voids more than 1/8 inch in any dimension but not less than 1/2 inch in depth:
 - a. Rub surfaces until smooth and in uniform plane with adjacent surfaces.
 - b. Clean and dampen surface and then brush coat surface with cement patching mortar mixed with water and work into voids, air-pockets and surface holes. Rub surface with sponge float trowel to remove excess grout flush with surface of panel.
 - c. After initial patch has set, apply second coat of patching mortar, then sand rub to eliminate remaining defects and blemishes and produce a smooth uniform plane surface free of grout film, rubbing marks and surface defects.
 3. Chamfer and Reveals: Remove fins, projections and mortar-seepage formed from reveal strip irregularities. Patch and fill edges to match panel surface finish.
- D. Perform structural repairs of concrete, subject to Structural Engineer's approval, using epoxy adhesive and patching mortar.
- E. Install sealants along interior and exterior vertical joints in accordance Section 07 92 00 "Joint Sealants".

3.10 CASTING-BED FLOOR SURFACE REPAIR

- A. Repair interior floor slabs-on-grade damaged from tilt-panel edge-form anchors.
- B. Remove chamfer and reveal strip forms and fasteners from floor slabs. Fill and repair floor slab surfaces damaged by fasteners, to match adjacent floor slab finish.
- C. Remove temporary floor joint fillers and air-blast joint clean of debris for proper application of permanent joint sealants.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for

quality control may include those specified in this Article. An ACI Field Grade 1 Certified technician shall cast all test cylinders and perform all slump cone tests.

- B. Testing Services: 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 (four cylinders) for each day's pour of each concrete mix exceeding 10 cu. yd. One set of test cylinders may represent no more than 50 cubic yards of concrete or one day's pour
 - 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each concrete mix on each truck delivery load. Concrete used for slump cone test shall not be taken from first or last 15% of each load. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 - 4. Compressive-Strength Tests: ASTM C 39 as follows:
 - a. Test two field-cured specimens at 7 days and two at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. Strength of each concrete mix will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Structural Inspector, 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 mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- E. 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 or by other methods as directed by Engineer of Record.

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SECTION 04 01 20

MASONRY CLEANING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Chemical cleaning for exterior masonry.
- B. Related Sections include the following:
 - 1. Section 04 22 13 for "Concrete Unit Masonry" for water-repellent admixture that is mixed integral with the manufacturer of concrete masonry units.
 - 2. Section 07 19 00 for "Water-Repellent Sealer" for cleaning of masonry construction prior to application of sealer.

1.02 SYSTEM DESCRIPTION

- A. Performance Requirements: Cleaning agent and application methods shall not adversely affect the appearance of or porosity of concrete masonry units. Muriatic acid shall not be used as a cleaning agent.

1.03 REFERENCES

- A. National Concrete Masonry Association (NCMA)
 - 1. TEK 8-02A – Removal of Stains from Concrete Masonry
 - 2. TEK 8-04A – Cleaning Concrete Masonry

1.04 SUBMITTALS

- A. Product Data: Product descriptions, surface preparations and manufacturer's application instructions and coverage rates for each masonry substrate.

1.05 QUALITY ASSURANCE

- A. Masonry Manufacturer Approvals: Provide masonry unit manufacturer's approval for application of the specific cleaning agents to be used for the specific masonry types and colors for the Project.
- B. Masonry Sealer Approvals: Provide documentation of masonry sealer manufacturer's approval for application of the specific cleaning agents to be used are compatible with masonry sealer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect material containers from freezing or physical damage and from deterioration by moisture and other sources. Comply with manufacturers written instructions for handling and storage.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Cleaning Agent: Proprietary non-muriatic acid water-soluble blend to be used in combination with a wetting agent. Subject to compliance with requirements, acceptable cleaning products include:
 - 1. Integral-color masonry to receive water-repellant sealer:
 - a. Architectural Masonry Cleaner; Diedrich Technologies-Hoffman & Barnard Co.
 - b. NMD 80; EaCo Chem, Inc.
 - c. Custom Masonry Cleaner; ProSoCo, Inc.
- B. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure trisodium polyphosphate and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water for removal of cleaning agent residue.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for substrates and related work and other conditions affecting performance.
 - 1. Verify that exposed mortar joints have cured and have been uniformly tooled to a dense, concave surface and have been dry-brushed clean of excess mortar.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Use suitable masking and all means necessary to protect metal, glass and other adjacent materials from cleaning agent application. Immediately remove over-spray in the event of staining or damage.
- B. Protect sidewalks and other horizontal surfaces from over-spray and runoff by soaking with water until properly diluted.
- C. Primary efflorescence shall be removed by dry brushing prior to pre-soaking or application of masonry cleaners in accordance with NCMA TEK Bulletin No. 8-02A.

3.03 APPLICATION

- A. General: Follow manufacturer's instructions for application methods and coverage rates for each substrate where cleaning agent and rinsing agent will be applied.
 - 1. Pre-soak surfaces with water to prevent excessive absorption of cleaning agent within the wall.
 - 2. Cleaning agent shall be diluted as recommended by manufacturer and applied with a stiff brush working from bottom of wall progressively overlapping application towards top of wall, saturating surface, avoiding excessive run-down of cleaning material. Do not apply with pressure sprayer.
 - 3. Allow cleaning agent to remain on surfaces for 5 to 10 minutes, depending on substrate porosity, restricting the area of application such that cleaning agent is not allowed to dry.
 - 4. To minimize streaking, work from bottom to top of wall, thoroughly rinse walls with clean water to remove all residual acid emulsion. After the emulsion has been removed or sufficiently diluted, clean walls of loosened material and dirt with low-pressure (400 psi max.) water spray equipment. Follow NCMA TEK Bulletin No. 8-04A recommendations for mortar stain removal.

END OF SECTION

SECTION 04 05 13

MASONRY MORTAR WATER-REPELLENT ADMIXTURE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Water-repellent admixture for exterior building masonry mortar.
- B. Related Sections include the following:
 - 1. Section 04 01 20 for "Masonry Cleaning" for cleaning of masonry construction prior to application of sealers specified under 07 19 00 "Water-Repellent Sealers".
 - 2. Section 04 22 13 for "Concrete Unit Masonry" for water-repellent admixture integral to the manufacturer of concrete masonry units.

1.02 SYSTEM DESCRIPTION

- A. Performance Requirements: Water-repellent admixture shall be provided as integral admixture to the on-site mortar mix and the masonry concrete mix-design during the manufacture of the concrete masonry units. The combination of water-repellent admixture, water-repellent sealer and proper tooling of masonry joints shall provide a complete integral water-repellent system for exterior masonry walls meeting the following requirements:
 - 1. Admixture shall provide wind-driven rain resistance equivalent to Class E rating (for 72 hours) as defined by ASTM E 514, "Standard Test Method for Water Penetration and Leakage through Masonry".
 - 2. Mortar bond strength as determined by ASTM C 1357, "Standard Test Method for Evaluating Masonry Bond Strength", shall not be reduced by the use of water-repellent admixtures.
 - 3. Admixture proportioning recommendations ASTM C 1384 – "Standard Specification of Admixtures for Masonry Mortar".

1.03 SUBMITTALS

- A. Product Data: Product descriptions, specifications, mix preparations and application rates for masonry units and mortar required to meet warranty requirements.
- B. Manufacturers Approval: Masonry unit manufacturer shall submit copy of current Certification of Qualification issued by water-repellent manufacturer.
- C. Warranty: Submit manufacturer's warranty and any special procedures required for warranty compliance.

1.04 QUALITY ASSURANCE

- A. Manufacturers Qualifications:
 - 1. Water-Repellent Manufacturer: Provide documentation showing evidence of producing water-repellent material that has maintained water repellency for over 5 years of continuous field exposure.
 - 2. Masonry Unit Manufacturer: Provide documentation showing evidence of producing water-repellent masonry units that have maintained water repellency for over 5 years of continuous field exposure.
- B. Pre-Installation Conference: Prior to installation of masonry wall components, a job-site meeting shall be held with the masonry sub-contractor, masonry admixture and masonry sealer representatives to

ensure that all parties involved in the construction of the masonry Work understand the procedures required to achieve a water-repellent masonry wall assembly.

1.05 WARRANTY

- A. Admixture Warranty: Provide written warranty by Admixture Manufacturer that products are free of defects and meet the Manufacturer's published physical and chemical properties.
- B. Masonry Manufacturers Warranty: Provide written warranty by Masonry Units Manufacturer that admixture has been integrated into the mix-design, at the recommended rate of application for all masonry units shipped to jobsite for use in the exterior walls.
- C. Masonry Installer Warranty: Provide written guarantee for a period of three (3) years from date of Substantial Completion against poor workmanship or improper application of water-repellent admixture and that admixture was included in the mortar mix in accordance with application rates required by admixture manufacturer.
- D. Remedial Repairs: Should water penetration occur on interior surfaces during the warranty period and is determined to be penetrating through exterior masonry wall assemblies, Masonry Installer shall repair and retool defective units or joints and provide additional topical coating sealer material and shall make necessary repairs and reapplication of coating material at no cost to Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Water-Repellent Admixture: Dry-powder admixture formulated for jobsite mixing with mortar mix and compatible with concrete masonry integral water-repellent mix-designs used in the manufacturing of concrete masonry units. Acceptable admixture products include:
 - 1. MasterPel 210D; BASF Corp.
 - 2. Hydrapel; Euclid Chemical.
 - 3. Dry-Block; Grace Construction Products.
 - 4. Minimum Dosage Rate: as recommended by admixture Manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION, INSTALLATION AND APPLICATION

- A. In accordance with Section 04 22 23 – "Concrete Unit Masonry".
 - 1. Mortar Mix: Combine mortar admixture to mortar mix at manufacturer's recommended rates and written instructions.

3.02 FIELD QUALITY CONTROL

- A. Field Water-Penetration Test: Refer to Section 07 19 00 – "Water-Repellent Sealer" for field testing of masonry wall assemblies. Conduct test in the presence of Architect's and Owner's representatives.

END OF SECTION

SECTION 04 22 23

CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:
 - 1. Exterior wall integral-color concrete masonry units.
 - 2. Exterior wall integral-color solid concrete masonry cap units.
 - 3. Integral-color concrete masonry seat walls.
 - 4. Mortar and grout.
 - 5. Ties and anchors.
 - 6. Miscellaneous masonry accessories.
- B. Related Sections include the following:
 - 1. Section 04 01 20 "Masonry Cleaning" for surface-applied cleaning agents applied to unit masonry.
 - 2. Section 04 05 13 "Masonry Mortar Water-Repellent Admixture" for admixture mixed with unit masonry joint mortar.
 - 3. Section 07 19 00 "Masonry Sealer" for surface-applied water repellent sealers applied to unit masonry.
 - 4. Section 07 62 00 "Sheet Metal Flashing and Trim" for embedded sheet metal flashing, if any.

1.01 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C 90 – Specification for Loadbearing Concrete Masonry Units.
 - 2. ASTM C 91 – Standard Specification for Masonry Cement.
 - 3. ASTM C 270 – Standard Specification for Mortar for Unit Masonry.
 - 4. ASTM C 476 – Standard Specification for Grout for Masonry.
 - 5. ASTM C 1072 – Standard Test Methods for Measurement of Masonry Flexural Bond Strength.
 - 6. ASTM C 1601 - Standard Test Methods for Field Determination of Water Penetration of Masonry Wall Surfaces.
 - 7. ASTM E 514 – Standard Test Method for Water Penetration and Leakage Through Masonry.
- B. National Concrete Masonry Association (NCMA)
 - 1. TEK 8-02A – Removal of Stains from Concrete Masonry
 - 2. TEK 9-04A – Grout for Concrete Masonry
 - 3. TEK 19-02B – Design for Dry Single-Wythe Concrete Masonry Walls

1.02 SUBMITTALS

- A. Product Data: For each different masonry unit, accessory, and other manufactured product specified.
- B. Samples for Verification:
 - 1. 4-inch square units for each different exposed integral-color masonry unit required, showing the full range of colors and textures to be expected in the completed construction.
 - 2. Colored mortar Samples for each color required, showing the full range of colors expected in the finished construction. Make samples using the same sand and mortar ingredients to be used on Project.
- C. Material Certificates: Signed by manufacturers certifying that masonry units complies with requirements:
 - 1. Each type of masonry unit required.
 - a. Classification in accordance with ASTM C90.

- b. Integral water-repellent admixture certification.

1.03 QUALITY ASSURANCE

- A. Masonry Units Certifications: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, supplied by a manufacturer participating in the Certified Block Program of the Arizona Masonry Guild.
- B. Installer Qualifications: The Masonry Subcontractor shall have a supervisor on the jobsite, whenever masonry work is performed, who is certified by the Arizona Masonry Contractors Association.
- C. Quality Standards: Levels of Quality – Standard 107 of the Arizona Masonry Guild (AMG) shall apply and by reference hereby made a part of this Specification. Reference to Custom, Standard or Economy shall be as defined in the AMG Standard 107.
- D. Mockups: Before installing unit masonry, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups using materials indicated for the completed Work:
 - 1. Build mockups for masonry in sizes approximately 96 inches long by 48 inches high.
 - 2. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship. Maintain mockups during construction in an undisturbed condition as a standard for comparing the completed Work. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units and cementitious materials on elevated platforms in a dry location. Replace materials that become wet or damaged.

1.05 PROJECT CONDITIONS

- A. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry. Protect all surfaces, including window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
- B. Coordination: Coordinate Work of others required during concrete masonry installation for placement of embeds, furring conduits, penetrations and other related items.

1.06 WARRANTY

- A. Masonry Manufacturers Warranty: Provide written warranty by Masonry Units Manufacturer that admixture has been integrated into the mix-design, at the recommended rate of application for all masonry units shipped to jobsite for use in the exterior walls.
- B. Masonry Installer Warranty: Provide written guarantee for a period of three (3) years from date of Substantial Completion against poor workmanship or improper application of water-repellent admixture and that admixture was included in the mortar mix in accordance with application rates required by admixture manufacturer.

PART 2 - PRODUCTS

2.01 CONCRETE MASONRY UNITS

- A. General: Provide special shapes for lintels, corners, jambs, bond-beams, and other conditions.
- B. Concrete Masonry Units: ASTM C 90 and as follows:
 - 1. Unit Compressive Strength: Provide units with minimum three unit average net-area compressive strength of 1900 psi and individual unit net-area compressive strength of 1700 psi.
 - 2. Weight Classification: Medium weight, weighing not less than 105 lbs. per cubic foot.
 - 3. Standard Masonry Units: Manufacturer's standard smooth faced units at interior locations where concealed from view.
 - 4. Exposed Smooth-Face Masonry Field Units: Manufacturer's standard smooth-face integral-color units. Provide smooth-face integral-color finish on all exterior-side faces exposed to view.
 - a. Unit Size; 8 x 8 x 16 inches nominal; standard and solid types.
 - b. Manufacturer: Trenwyth Industries.
 - c. Color: Fuego Red and Mohave Brown.
 - 5. Exposed Split-Face Masonry Field Units: Manufacturer's standard split-face integral-color units. Provide split-face integral-color finish on all exterior-side faces exposed to view.
 - a. Unit Size; 8 x 8 x 16 inches nominal; standard and solid types.
 - b. Manufacturer: Trenwyth Industries.
 - c. Color: Black Canyon
 - 6. Exposed Smooth-Face Masonry Accent Units: Manufacturer's standard smooth-face integral-color units. Provide smooth-face integral-color finish on all exterior-side faces exposed to view.
 - a. Unit Size; 8 x 4 x 16 inches nominal; standard and solid types.
 - b. Wall Cap Units: 8 x 4 x 16 inches nominal; solid.
 - c. Manufacturer: Trenwyth Industries.
 - d. Color: Pearl
 - 7. Integral Water-Repellent Admixture: Provide concrete masonry units for exterior building walls that contain a water-repellent admixture additive incorporated into the concrete mix at the time of masonry unit manufacturer. Mix admixture proportions in accordance with admixture manufacturers certification program that do not reduce the flexural bond strength of the masonry unit per ASTM C 1072.
 - a. Approved Manufacturer: MasterPel 240MA Water-Repellent Admixture; BASF Corp.
 - b. Minimum Dosage Rate: 4 oz/cwt of cement.

2.02 MORTAR AND GROUT MATERIALS

- A. Cement: ASTM C 150, Type II, provide natural color or white cement as required to produce mortar colors indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Aggregate for Mortar: ASTM C 144.
- D. Aggregate for Grout: ASTM C 404.
- E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar, as selected from manufacturer's standard formulation.
 - 1. Colors: Davis Colors to match masonry color.
- F. Water: Potable.

2.03 REINFORCING STEEL

- A. Uncoated Steel Reinforcing Bars: ASTM A 615, Grade 60 for bars No. 6 to No. 18; Grade 40 for bars No. 3 to No. 5.

2.04 MASONRY JOINT REINFORCEMENT

- A. General:

1. Exterior Walls: Hot-dip galvanized, carbon-steel wire, ASTM A 82 with ASTM A 153, Class B-2 coating.
1. Interior Walls: Mill galvanized, carbon-steel wire ASTM A 82 with ASTM A 641, Class 1 coating.
2. Provide in lengths of not less than 10 feet with prefabricated corner and tee units.

2.05 TIES AND ANCHORS

- A. Veneer Wall Anchors: ASTM A 1008, 12 ga. galvanized sheet metal wall-plate with 3/16" pre-bent rod anchors.
 1. Approved Manufacturers:
 - a. 345-BT: Hohmann & Barnard, Inc.
 - b. CTP-16; Construction Tie Products; Prosoco, Inc.
 - c. 315-D; Heckmann Building Products.

2.06 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Material as indicated below, designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Plastic Weep Hole/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, designed to fill head joint with outside face held back 1/8 inch from exterior face of masonry, in color to match masonry.

2.07 MASONRY CLEANERS

- A. Masonry Cleaner: Refer to Section 04 01 20 "Masonry Cleaning" for surface-applied cleaning agents applied to unit masonry.

2.08 MORTAR AND GROUT MIXES

- A. General: Do not use air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated. Do not use calcium chloride in mortar or grout.
- B. Mortar for Unit Masonry: Comply with ASTM C 91 and ASTM C 270 Proportion Specification.
 1. Limit cementitious materials in mortar to portland cement, mortar cement, and lime.
 2. For reinforced masonry and where indicated, use Type S, 1800 psi compressive strength.
 3. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required. Limit pigments to not more than 10 percent of cement content by weight.
 - a. Mortar Color: Cohills "Natural Honey" #54; 2 lbs. of color to 94 lbs. of cement.
- C. Grout for Unit Masonry: Comply with ASTM C 476 for coarse grout for use in construction of reinforced and non-reinforced unit masonry. Use coarse grout of consistency at time of placement with NCMA TEK Bulletin No. 8-4A recommendations for grout proportions.
 1. Minimum compressive strength (28 Days): 2000 psi.
 2. Maximum slump: 8 inches.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supporting structure and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting unit masonry installation. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Prepare written report listing conditions which are unacceptable to proper installation of masonry.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing and dowels are properly located and anchored.
- B. Before installation, examine rough-in and built-in construction to verify actual locations of piping or electrical connections.
- C. Do not install masonry units or materials that are damaged or visible in the finished Work.

3.02 INSTALLATION, GENERAL

- A. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.
- B. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed. Build walls and other masonry construction to the full thicknesses shown.

3.03 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4" in 10', or 1/2" maximum in 40' or more. For external corners, expansion joints, control joints and other conspicuous lines, do not exceed 1/4" in any story or 1/2" in 40' or more. For vertical alignment of head joints do not exceed plus or minus 1/4" in 10'.
- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4" in any bay or 20' maximum, nor 1/2" in 40' or more. For top surface of bearing walls do not exceed 1/8" between adjacent floor elements in 10' or 1/16" within width of a single unit.
- C. Variation in Mortar Joint Thickness: Joints shall be straight, clean and a uniform thickness of 3/8 inch. Do not exceed bed joint thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2".

3.04 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing and coursing of bond patterns with uniform joint thickness and for accurate location of openings, control joints, returns, and offsets. Do not use less than half-size units at corners, jambs, and, where possible, at other locations.
- B. Workmanship: Provide Standard level workmanship as defined by AMG Standard 107.
 - 1. Select and arrange units for exposed integral-color unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- C. Bond Pattern for Exposed Masonry: Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
 - 1. One-half running bond with vertical joint in each course centered on units in courses above and below.
 - 2. Stack-bond with vertical joint in each course centered on vertical joints above and below each course.

- D. Built-in Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items and maintain 1/2 inch clearance for sealant applications.
- E. Fill cores in hollow concrete masonry units with grout under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

3.05 MORTAR BEDDING AND JOINTING

- A. Lay hollow masonry units as follows:
 - 1. With full mortar coverage on horizontal and vertical face shells.
 - 2. Bed webs in mortar in starting course on footings and in all courses of piers, columns, and pilasters, and where adjacent to cells or cavities to be filled with grout.
 - 3. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.
- B. Lay masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints after placement.
- C. Joints shall be tooled flush at:
 - 1. At below-grade locations and surfaces to receive dampproofing or waterproofing.
 - 2. Surfaces to receive stucco, EIFS, and other veneer finishes.
- D. Joints shall be tooled concave at:
 - 1. At exposed wall construction. Rake joints are not permitted.
 - 2. Bee-holes, pin-holes and other defects in joints shall be filled to prevent water penetration.

3.06 MASONRY JOINT REINFORCEMENT

- A. General: Provide continuous masonry joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
- B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.07 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joints in unit masonry. Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall movement. Joint spacing as follows:
 - 1. Site Walls: Maximum of 30'-0" o. c. unless otherwise indicated on Drawings.
 - 2. Building Walls: Maximum of 24'-0" o. c. unless otherwise indicated on Drawings.
- B. Form control joints in concrete masonry as follows:
 - 1. Provide flat, square-end units at each side of joint. Fit bond-breaker strips in between ends of concrete masonry units full height of control joint.
 - 2. Form open joint of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 07 92 00 - "Joint Sealants." Keep joint free and clear of mortar.

3.08 REINFORCED UNIT MASONRY INSTALLATION

- A. Placing Reinforcement: Place in accordance with requirements as indicated on Drawings. Complete inspections before grouting.

- B. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
 - 1. Comply with requirements of ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, stopping pours 2 inches below top of cell to form a key for next grout pour.
 - 2. Fill cells completely with grout and consolidate by vibration in lifts not to exceed 4 feet.

3.09 FIELD QUALITY CONTROL

- A. Owner will engage a qualified independent testing agency to perform field quality-control testing in accordance with Section 01 10 00.
 - 1. Materials failing to meet specified requirements shall be retested at Contractor's expense.
- B. Grout will be sampled and tested for compressive strength per ASTM C 1019.
- C. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

3.10 REPAIRING, POINTING, CLEANING AND SEALING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point and fill joint pin-holes and cracks, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application where indicated.
- C. In-Progress Cleaning: Clean unit masonry within 48 hours as work progresses by dry brushing to remove mortar fins and smears before tooling joints. Use extreme care to prevent grout or mortar from staining integral-color units. Follow NCMA TEK Bulletin No. 8-2A recommendations.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry. Protect adjacent non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
- E. Sealing of Masonry: Not less than 30 days before Substantial Completion, clean exposed masonry of efflorescence, dirt, paint over-spray and other surface contaminants and apply masonry sealer at application rates in accordance with Section 07 19 00 - "Water-Repellent Sealer."

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SECTION 04 72 13

PRECAST CONCRETE TRIM UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes precast concrete specialties consisting of the following:
 - 1. Masonry seat walls caps.
 - 2. Masonry wall pier element caps.

1.02 SUBMITTALS

- A. Design Mixes: For each concrete mix.
- B. Shop Drawings: Detail fabrication and installation of precast concrete specialties. Indicate locations, dimensions, shapes, cross sections, limits of each finish, and types of reinforcement.

1.03 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm that complies with the following requirements and is experienced in manufacturing precast concrete specialties similar to those indicated for this Project.

PART 2 - PRODUCTS

2.01 PRECAST CONCRETE UNITS

- A. Precast Units: 4-inch thick, in configurations indicated on Drawings:
 - 1. Unit Color:
 - a. Seat Wall Cap Color: Davis Color; "Outback - 5237", 0.5 lbs per 94 lbs of cement.
 - b. Finish: light sandblast.
- B. White Portland Cement: ASTM C 150, Type II.
 - 1. Fly Ash is not acceptable in exposed precast concrete.
- C. Aggregate: ASTM C 33, uniformly graded, from a single source, with coarse aggregate as follows:
 - 1. Maximum Aggregate Size: 3/8 inch nominal.
 - 2. Sand: Clean, washed natural sand.
- D. Proportion mixes to provide concrete units with the following properties:
 - 1. Compressive Strength (28 Days): 5000 psi

2.02 SETTING MATERIALS

- A. Water-Cleanable Epoxy Adhesive: ANSI A118.3.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C-Cure.
 - b. Custom Building Products.
 - c. Laticrete International, Inc.

2.03 REINFORCING MATERIALS

- A. Plain-Steel Welded Wire Fabric: ASTM A 1064, fabricated from as-drawn steel wire into flat sheets.

2.04 MOLD MATERIALS

- A. Molds: Provide molds and, where required, form-facing materials of metal, plastic, wood, or another material that is nonreactive with concrete and dimensionally stable to produce continuous and true precast concrete surfaces within fabrication tolerances and suitable for required finishes

2.05 MOLD FABRICATION

- A. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes.
- B. Maintain molds to provide completed precast concrete specialties of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
 - 1. Edge and Corner Treatment: Uniformly radiused.

2.06 FABRICATION

- A. Reinforcement: Comply with recommendations in CRSI's "Manual of Standard Practice" and PCI MNL 117 for fabricating, placing, and supporting reinforcement.
 - 1. Place reinforcement to maintain at least 3/4-inch minimum coverage. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
- B. Reinforce precast concrete specialties to resist handling or transportation damage.
- C. Mix concrete according to PCI MNL 117 and requirements in this Section. After concrete batching, no additional water may be added.
- D. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items.
- E. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture.

2.07 FABRICATION TOLERANCES

- A. Fabricate precast concrete specialties straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.
- B. Fabricate precast concrete specialties straight and true to size and shape with exposed edges and corners precise and true so each finished panel complies with the following product tolerances:
 - 1. Total Thickness: Plus 1/4 inch, minus 1/8 inch.
 - 2. Variation from Square: Plus or minus 1/8 inch per 48 inches or 1/4 inch total, whichever is greater.
 - 3. Bowing: Plus or minus L/360, maximum 1 inch.

2.08 FINISHES

- A. Finish all surfaces of precast concrete specialties to match approved samples and as follows:
 - 1. Light Sandblast Finish: Use sandblasting equipment and techniques, to remove surrounding surface cement matrix to a penetration depth of not more than 1/16 inch and exposing surface fine aggregates.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install precast concrete specialties. Provide temporary supports and bracing as required to maintain position, stability, and alignment as units are being permanently placed.
 - 1. Maintain horizontal and vertical alignment as installation progresses.

3.03 ERECTION TOLERANCES

- A. Install precast concrete specialties level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

3.04 REPAIRS

- A. No repairs allowed. Remove and replace damaged precast concrete specialties that do not comply with requirements.

3.05 PROTECTION AND CLEANING

- A. Clean exposed surfaces of precast concrete specialties after erection to remove marks, other markings, dirt, and stains.
 - 1. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes.

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SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Structural steel beams and columns.
 - 2. Lintels, shelf angles and miscellaneous structural steel items.
 - 3. Non-shrink grout.
- B. Related Sections include the following:
 - 1. Section 03 30 00 for "Cast-In-Place Concrete" for embedment of steel anchorage devices in concrete
 - 2. Section 09 91 13 for "Painting" for surface preparation and requirements for finish painting of exposed structural steel.

1.02 SUBMITTALS

- A. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include anchor bolt and embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.
- B. Test Reports: Submit reports for welded connection tests.
- C. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Tension-control, high-strength bolt-nut-washer assemblies.

1.03 QUALITY ASSURANCE

- A. Welding:
 - 1. Performed by certified welders in compliance with procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- B. Certifications:
 - 1. Prior to fabrication, furnish certification of Manufacturer that structural steel material furnished meets or exceeds requirements of ASTM standards referenced.
 - 2. Prior to any site welding operation, submit welders certifications and qualifications.

1.04 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 or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean bolts and nuts that become rusty before use.

2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.05 COORDINATION

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

PART 2 - PRODUCTS

2.01 STRUCTURAL-STEEL MATERIALS

- A. Structural Steel Shapes: ASTM A 992.
- B. Steel Shapes, Plate and Bars: ASTM A 36 and ASTM A 572.
- C. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- D. Steel Pipe: ASTM A 53, Grade B.
- E. Steel tube columns: ASTM A500, Grade B.
- F. Welding Electrodes: Comply with AWS requirements.

2.02 BOLTS, CONNECTORS, AND ANCHORS

- A. Anchor Bolts, Nuts, and Washers: ASTM A 307, ASTM A 325 Type 1 where indicated and ASTM F 436 hardened carbon-steel washers.
- B. Threaded Rods: ASTM A 36 or ASTM A 307, Grade A.
- C. Clevises/Turnbuckles: ASTM A 108, Grade 1035, cold-finished carbon steel.
- D. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.

2.03 PRIMER

- A. Ferrous Metal Primer: VOC compliant, water-based modified alkyd primer. Approved coatings include:
 1. Sunburst Coatings: 38 Series. Color 38F2 Dark Gray
 2. Sherwin Williams: B66-A310 Universal Primer. Color: Dark Gray.

2.04 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: 5000 psi, ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application.
- B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404, Size No. 2. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

2.05 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings".
 - 1. Camber structural-steel members where indicated.
 - 2. Mark and match-mark materials for field assembly.
 - 3. Complete structural-steel assemblies, including welding, before starting shop-priming operations.
- B. Architecturally Exposed Structural Steel: Comply with fabrication requirements, including tolerance limits, of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for structural steel identified as architecturally exposed structural steel.
- C. 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.
- D. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

2.06 SHOP PRIMING

- A. Shop prime steel surfaces except 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."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 3.0 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Provide temporary shores, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and wind loads. Remove temporary supports when permanent structural steel and connections, are in place, unless otherwise indicated.

3.03 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings".
- B. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
 - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Weld plate washers to top of base plate.

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 base or bearing plate before packing with grout.
 4. Promptly pack grout solidly between bearing surfaces and base or bearing 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. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Maintain individual members of structure level and plumb.
 - D. Splice members only where indicated and approved on shop drawings.
 - E. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
 - F. Do not use thermal cutting during erection unless approved by Structural Engineer of Record. Finish thermally cut sections within smoothness limits in AWS D1.1.
 - G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.04 FIELD 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.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
 2. Remove backing bars or runoff tabs, 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: Shop-bolted connections will be 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.
 1. In addition to visual inspection, field welds may be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Ultrasonic Inspection: ASTM E 164.
 - c. Radiographic Inspection: ASTM E 94.
- D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.06 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
 - 2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Metal Seam Sealant: After framing installation and primer repairs, install continuous bead of sealant at metal seams between adjoining metal framing members exposed to view. Tool bead concave to match width of welds at non-welded joints. Paint sealant joints to match adjacent steel in accordance with Section 09 91 13 for "Painting" for surface preparation and requirements for finish painting of exposed structural steel.

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SECTION 05 21 00

STEEL JOISTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Open-web K-series steel roof joists.
 - 2. Joist-girders.
 - 3. Joist accessories.
- B. Related Sections include the following:
 - 1. Section 01 10 00 for "General Requirements" for joists deferred AHJ submittal requirements.
 - 2. Section 03 47 00 for "Site-Cast Tilt-Panel Concrete" for installing bearing plates and ledger angles in tilt-panel concrete.
 - 3. Section 05 50 00 for "Metal Fabrications" for furnishing steel bearing plates.
 - 4. Section 09 91 16 for "Painting" for painting of steel joists and joist girders.

1.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide special joists and connections capable of withstanding design loads within limits and under conditions indicated.
- B. Design joists to support future point loads as follows:
 - 1. Point load of 2000 pounds at any point along joist in addition to mechanical equipment loads shown on Drawings and future mechanical at any point along joists of 500 pounds.
- C. Design joists to withstand design loads with live load deflections no greater than the following:
 - 1. Vertical live-load deflection of 1/240 of the span.
 - 2. Vertical total-load deflection of 1/180 of the span.
 - 3. Maximum live-load deflection of perimeter joist: 1/2 inch.

1.03 SUBMITTALS

- A. Shop Drawings: Show layout, mark, number, type, location, and spacings of joists. Include joining and anchorage details, bracing, bridging, accessories; splice and connection locations and details; and attachments to other construction.
 - 1. Indicate locations and details of anchorage devices and bearing plates to be embedded in other construction.
 - 2. Engineering analysis certified by the qualified professional engineer responsible for its preparation.
- B. Welding Certificates: Copies of certificates for welding procedures and personnel.
- C. Research/Evaluation Reports: Evidence of steel joists' compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A firm experienced in manufacturing joists similar to those indicated for this Project and with a record of successful in-service performance.

1. Manufacturer must be certified by SJI to manufacture joists complying with SJI standard specifications and load tables.
 2. Assumes responsibility for engineering special joists to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
 3. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of joists that are similar to those indicated for this Project in material, design, and extent.
- B. SJI Specifications: Comply with SJI's "Standard Specifications Load Tables and Weight Tables for Steel Joists and Joist Girders", applicable to types of joists indicated.
- C. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel"; and AWS D1.3 "Structural Welding Code--Sheet Steel."

1.05 SEQUENCING

- A. Coordinate the delivery of steel bearing plates and other devices to be built into concrete and masonry construction.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel: Comply with SJI's "Specifications" for chord and web members.
- B. Steel Bearing Plates: ASTM A 36.
- C. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
1. Finish: Plain, uncoated.
- D. High-Strength Bolts and Nuts: ASTM A 325, Type 1, heavy hex steel structural bolts, heavy hex carbon-steel nuts, and hardened carbon-steel washers.
1. Finish: Plain, uncoated.
- E. Welding Electrodes: Comply with AWS standards.

2.02 PRIMERS

- A. Metal Primer: Fast-curing, lead- and chromate-free, VOC compliant, water-based modified alkyd acrylic primer. Approved coatings include:
1. Sunburst Coatings: 38 Series. Color 38F2 Dark Gray
 2. Sherwin Williams: B66-A310 Universal Primer. Color: Dark Gray.

2.03 OPEN-WEB STEEL JOISTS

- A. Manufacture steel joists according to "Standard Specifications for Open Web Steel Joists" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord; of joist type indicated.
1. Joist Types: as indicated on Drawings.

- B. Comply with AWS requirements and procedures for shop welding, appearance, quality of welds, and methods used in correcting welding work.
- C. Provide holes in chord members for connecting and securing other construction to joists, where indicated.
- D. Camber joists for design dead-load and as indicated.
- E. Top-Chord Extensions: Extend top chords of joists with SJI's Type S top-chord extensions where indicated, complying with SJI's "Specifications."
- F. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes where joist slope exceeds 1/4 inch per 12 inches.

2.04 JOIST GIRDERS

- A. Manufacture joist girders according to "Standard Specifications for Joist Girders," in SJI's "Specifications," with steel-angle top- and bottom-chord members; with end and top-chord arrangements as indicated.
- B. Provide holes in chord members for connecting and securing other construction to joist girders.
- C. Camber joists for design dead-load and as indicated.
- D. Equip bearing ends of joists with manufacturer's standard beveled ends or sloped shoes if joist slope exceeds 1/4 inch per 12 inches.

2.05 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging as schematically indicated. Detail and fabricate according to SJI's "Specifications."
- B. Fabricate steel bearing plates with integral anchorages of sizes indicated. Shop prime paint.
- C. Supply extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support piping construction over 4 inches in diameter. Extend ends to within 3 inches of finished wall surface, unless otherwise indicated.
- D. Supply miscellaneous accessories, including splice plates and bolts required by joist manufacturer to complete joist installation.

2.06 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories to be primed by hand-tool cleaning, SSPC-SP 2 or power-tool cleaning, SSPC-SP 3.
- B. Apply one shop coat of primer to joists and joist accessories to be primed to provide a continuous, dry paint film not less than 3.0 mils thick.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supporting substrates, embedded bearing plates, and structural framing, with Installer present, for compliance with requirements for installation tolerances and conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
- C. Field weld joists to supporting steel bearing plates. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using high-strength structural bolts, unless otherwise indicated. Comply with RCSC's "Allowable Stress Design Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts".
- E. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.03 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. Field welds will be visually inspected according to AWS D1.1.
- C. Bolted connections will be visually inspected.
- D. Correct deficiencies in Work that inspections and test reports have indicated are not in compliance with specified requirements.
- E. Additional testing will be performed to determine compliance of corrected Work with specified requirements.

3.04 REPAIRS AND PROTECTION

- A. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates and abutting structural steel.
 - 1. Clean and prepare surfaces by hand-tool cleaning, SSPC-SP 2, or power-tool cleaning, SSPC-SP 3.
 - 2. Apply a compatible primer of the same type as the shop primer used on adjacent surfaces.

END OF SECTION

SECTION 05 31 23

STEEL DECKING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Galvanized steel roof deck.
- B. Related Sections include the following:
 - 1. Section 07 72 00 for "Roof Accessories" for framing deck openings and expansion joint assemblies, if any.
 - 2. Section 09 91 16 for "Painting" for painting of metal decking.

1.02 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.
- C. Product Certificates: Deck manufacturer certification that products furnished comply with requirements.
- D. Welding Certificates: Copies of certificates for welding procedures and personnel.
- E. Research/Evaluation Reports: Evidence of steel deck's compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

1.03 QUALITY ASSURANCE

- A. Certifications:
 - 1. Prior to fabrication, furnish certification of Manufacturer that structural steel material furnished meets or exceeds requirements of ASTM standards referenced.
 - 2. Prior to any site welding operation, submit welders certifications and qualifications.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

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 the following:
 - 1. Nucor Corp.; Vulcraft Div.
 - 2. Verco Manufacturing Co.
 - 3. New Millennium Building Systems.

2.02 ROOF DECK

- A. Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 29. Minimum allowable diaphragm shear, furnished per ICBO report, shall be 500 pounds per foot.
 - 1. Galvanized Steel Sheet: ASTM A 653, minimum yield stress of 50,000 psi, phosphatized, G90 zinc coating.
 - 2. Deck Profile: per General Structural Notes.
 - 3. Profile Depth: 1 1/2 inches.
 - 4. Design Uncoated-Steel Thickness: 20 gauge.
 - 5. Span Condition: Triple span or more.

2.03 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- D. Miscellaneous Sheet Metal Deck Accessories: steel sheet, of same material and finish as deck; of profile indicated or required for application.
- E. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 16 ga., with factory-punched hole of 3/8-inch minimum diameter.
- F. Galvanizing Repair Paint: ASTM A 780 SSPC-Paint 20, with dry film containing a minimum of 94 percent zinc dust by weight.

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.

3.02 INSTALLATION, GENERAL

- A. Install temporary shoring before placing deck panels, if required to meet deflection limitations.
- B. Locate decking bundles to prevent overloading of supporting members.
- C. Place deck panels on supporting frame with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to decking.
- E. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 29, manufacturer's written instructions, and requirements in this Section.
- F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.

- G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.03 DECK INSTALLATION

- A. Fasten deck panels to steel supporting members with powder-actuated shot-pins as follows:
 - 1. Deck Fastener Spacing: Refer to structural drawings for spacing and fastener types.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding 12 inches o.c. and as follows:
 - 1. Side-Laps: Mechanically clinch or button punch.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches with end joints lapped 2 inches minimum.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof decking and weld flanges to top of deck. Space welds not more than 12 inches apart with at least 1 weld at each corner.

3.04 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing agency to perform field quality-control testing. Field welds will be subject to inspection. Testing agency will report test results promptly and in writing to Contractor and Architect.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.05 REPAIRS

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

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SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Galvanized load-bearing wall and soffit steel framing.
- B. Related Sections include the following:
 - 1. Section 05 50 00 for "Metal Fabrications" for steel embeds and misc. connections.
 - 2. Section 06 16 13 for "Sheathing" for exterior sheathing board applications
 - 3. Section 09 22 16 for "Non-Structural Metal Framing" for interior metal wall and ceiling framing.
 - 4. Section 09 29 00 for "Gypsum Board" for interior gypsum board applications.

1.02 DEFINITIONS

- A. Minimum Uncoated Steel Thickness: Minimum uncoated thickness of cold-formed framing delivered to the Project site shall be not less than 95 percent of the thickness used in the cold-formed framing design thickness.

1.03 REFERENCES

- A. American Iron and Steel Institute (AISI):
 - 1. AISI S100-16 North American Specification for the Design of Cold-formed Structural Steel Structural Members.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - 2. ASTM A 1003 – Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Framing Members.
 - 3. ASTM C 955 – Specification for load-bearing Steel Studs, Runner Tracks, and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases.
- C. American Welding Society (AWS):
 - 1. AWS D1.3 – Structural Welding Code – Sheet Steel.
- D. Steel Stud Manufacturers Association (SSMA):
 - 1. Product Technical Information – ICBO ESR-3064P.
- E. Steel Framing Industry Association (SFIA):
 - 1. SFIA Code Compliance Certification Program.

1.04 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated. Maximum allowable deflection:
 - 1. Walls receiving gypsum sheathing or plaster stucco finishes: L/240.
 - 2. Walls receiving exterior tile finishes: L/360.

1.05 SUBMITTALS

- A. Product Data: For each type of cold-formed metal framing product and accessory indicated.
- B. Research/Evaluation Reports: Evidence of cold-formed metal framing's compliance with current ICBO evaluation reports.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect cold-formed metal framing from corrosion, deformation, and damage during delivery and handling.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, furnish products as manufactured by a member of the Steel Stud Manufacturers Association (SSMA) or Steel Framing Industry Association (SFIC). Manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
 - 1. SCAFCO Steel Stud Co. (ICC ESR-3064P)
 - 2. CEMCO - California Expanded Metal Products Co. (ICC ESR-4205)
 - 3. Clark Dietrich Building Systems. (ICC ESR-1166P)
 - 4. United Metal Products. (ICC ESR-3064P)

2.02 LOAD-BEARING STEEL FRAMING MATERIALS

- A. Galvanized Steel Sheet: ASTM A 1003, Structural Grade, Type H, zinc-coated, of grade as follows:
 - 1. 16 ga. and heavier: Grade ST50H, 50,000 psi minimum yield strength.
 - 2. 18 ga. and lighter: Grade ST33H, 33,000 psi minimum yield strength.
 - 3. Zinc-Coating: G60.

2.03 WALL AND SOFFIT FRAMING

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, complying with ASTM C 955, and as follows:
 - 1. Flange Width: 2 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, complying with ASTM C 955, and as follows:
 - 1. One gauge heavier in thickness than C-stud gauge.
 - 2. Flange Width: 3 inches.
- C. Steel Slip Track: Slotted steel sheet top runner with 3-inch flange, manufactured to prevent stud deflection of interior partition framing resulting from deflection of structure above; 16 gauge thickness and in width to accommodate depth of studs

2.04 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories of the same material and finish used for framing members, with a minimum yield strength of 33,000 psi.

2.05 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A 36, zinc coated by hot-dip process according to ASTM A 123.
- B. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 4 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
- C. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing per ASTM E 1190 conducted by a qualified independent testing agency.
- D. Mechanical Fasteners: Corrosion-resistant-coated, self-drilling, self-threading steel drill screws.
 - 1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.
- E. Welding Electrodes: Comply with AWS standards.

2.06 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20 or ASTM A 780.
- B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for hydration.

2.07 FABRICATION

- A. Fabricate assemblies of framed sections of sizes and profiles required, with framing members fitted, reinforced and braced to suit design requirements and material dead loads.
- B. Fasten metal framing by welding or screw attachment. Wire-tying is not acceptable.
- C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:
 - 1. Spacing: Space individual framing members no more than plus or minus 1/4 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 - 2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Grout bearing surfaces, if any, uniform and level to ensure full contact of bearing flanges or track webs on supporting concrete or masonry construction.

3.03 INSTALLATION, GENERAL

- A. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to manufacturer's written recommendations and requirements in this Section.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten cold-formed metal framing members by welding or screw fastening, as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Comply with AWS D1.3 requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
 - b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
- B. Install framing members in one-piece lengths, unless splice connections are indicated for track or tension members.
- C. Do not bridge building expansion and control joints with cold-formed metal framing. Independently frame both sides of joints.
- D. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/4 inch in 10 feet and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch from plan location.

3.04 SOFFIT INSTALLATION

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 - 1. Anchor Spacing: 24 inches o.c., unless otherwise indicated.
- B. Squarely seat studs against webs of top and bottom tracks. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
 - 1. Stud Spacing: 16 inches o.c., unless otherwise indicated.
- C. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.
- D. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 - 1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings.
 - 2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- E. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, fasteners, and stud girts, to provide a complete and stable curtain-wall-framing system.

3.05 REPAIRS AND PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: Wire brush, clean, and paint scarred areas, welds, and rust spots on fabricated and installed prime-painted, cold-formed metal framing. Paint framing surfaces with same type of shop paint used on adjacent surfaces.

3.06 PRODUCT DESIGNATION SCHEDULE

- A. Sheet Metal Thickness: The following table is provided as a cross-reference to steel-stud designations and traditional minimum gauge thickness of framing members:

Designation Thickness	Design Thickness (in)	Reference Gauge No.
18 mil	0.0188	25 ga
30 mil	0.0312	20 ga
33 mil	0.0346	20 ga
43 mil	0.0451	18 ga
54 mil	0.0566	16 ga
68 mil	0.0713	14 ga

- B. Stud Designations: The following tables are provided as a cross-reference to SSMA steel-stud designations, calculated in accordance with ICC-ES AC86-15 for interior non-structural framing.
1. Web Depth Size: Indicated in decimal inches. Example: 3 5/8" equals 362; 6" equals 600, etc.
 2. Flange Depth: 2" equals 200.
 3. Shape Designation: 'S' for steel stud C-shape profile.
 4. Metal Thickness: Indicated in mil thickness and minimum steel gauge thickness.
 5. Maximum Span: Wind load at 20 psf (0.70 reducible), single span, 33 ksi steel, u.n.o.
- C. Span Table: The following table is provided as a cross-reference to steel-stud designations, calculated in accordance with AISI S100 for maximum deflection of L/240:

STUD SIZE	MIL	GA	STUD SPACING (in. o.c.)	MAXIMUM SPAN (ft)	YIELD STRENGTH
400S200-43	43	18	16	15'-4"	33 ksi
400S200-43	43	18	24	12'-7"	33 ksi
400S200-54	54	16	16	16'-7"	50 ksi
400S200-54	54	16	24	14'-6"	50 ksi
600S200-43	43	18	16	19'-7"	33 ksi
600S200-43	43	18	24	16'-0"	33 ksi
600S200-54	54	16	16	22'-8"	50 ksi
600S200-54	54	16	24	19'-10"	50 ksi

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SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Exterior steel trellis beams and columns.
 - 2. Landscape trellis panels.
 - 3. Pipe bollards.
 - 4. Steel ladders.
 - 5. Ladder safety cages.
 - 6. Cast-in steel embed plates and shelf angles.
 - 7. Loading-dock door cast-in corner guards and floor edge angles.
 - 8. Steel pipe guardrails.
 - 9. Steel framing supports for restroom countertops.
 - 10. Steel framing supports for operable partitions.
 - 11. Steel framing and supports for mechanical and electrical equipment.
 - 12. Steel framing and supports for applications where framing and supports are not specified in other Sections.
- B. Related Sections include the following:
 - 1. Section 03 47 00 for "Site-Cast Tilt-Panel Concrete" for coordination of cast-in steel embeds.
 - 2. Section 05 51 10 for "Steel Stairs" for steel stairs and associated stair pipe railings.
 - 3. Section 06 10 50 for "Rough Carpentry" for metal anchors and other rough hardware.
 - 4. Section 09 91 16 for "Painting" for painting of metal fabrications.
 - 5. Section 32 31 31 for "Fences and Gates" for sliding metal gates and rough hardware.

1.02 SUBMITTALS

- A. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated. Include plans and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 1. Provide templates for anchors and bolts specified for installation under other Sections.

1.03 QUALITY ASSURANCE

- A. 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.
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."

1.04 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.

1.05 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.

2.02 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Tubing: Cold-formed steel tubing complying with ASTM A 500.
- C. Steel Pipe: ASTM A 53, standard weight, unless otherwise is indicated.
- D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.03 PRIMER

- A. Interior Metal Primer: VOC compliant, water-based acrylic primer. Approved coatings include:
 - 1. Tnemec: 10-99W. Color: 1009 Gray.
 - 2. Sherwin Williams: B66-A310 Universal Primer. Color: Gray.
- B. Exterior Metal Primer: VOC compliant, modified alkyd primer. Approved coatings include:
 - 1. Tnemec: FD88 Primer. Color: 559 Gray.
 - 2. Sherwin Williams: B50AZ6 Universal Primer. Color: Gray.

2.04 GROUT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout recommended by manufacturer for specific applications.

2.05 FASTENERS

- A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, where built into exterior walls.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36.
- D. Machine Screws: ASME B18.6.3.
- E. Lag Bolts: ASME B18.2.1.

- F. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to four times the load imposed when installed in unit masonry or in concrete, as determined by testing per ASTM E 488.
 - 1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.

2.06 CONCRETE FILL

- A. Concrete Materials and Properties: Comply with requirements Section 03 30 00 - "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.07 FABRICATION, GENERAL

- 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.
- B. Shear and punch metals cleanly and accurately. Remove burrs.
- C. Ease exposed edges to a radius of approximately 1/16 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation.
- D. Weld corners and seams continuously to comply with the following:
 - 1. Use methods that minimize distortion and develop corrosion resistance of base metals.
 - 2. At exposed connections, finish exposed welds and surfaces smooth so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- F. Cut, reinforce, drill, and tap metal fabrications to receive finish hardware, screws, and similar items.
- G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.
- H. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- I. 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.

2.08 VERTICAL FENESTRATION PANELS

- A. Frames and Bracing:
 - 1. Frame Members: Fabricate members from steel tubing as indicated.
 - 2. Frame Corner Construction: Miter-cut, welded, flush-ground.
 - 3. Steel Finish: Primed painted to receive field applied enamel painted finish.
- B. Wire-Mesh Panels: 0.187-inch diameter, welded-wire square mesh sheet, 82% open area.
 - 1. Panel Size: 48" x 96".
 - 2. Wire Spacing: 2 per inch.
 - 3. Steel Finish: A-40 galvanized.
 - 4. Approved Manufacturers:
 - a. McNichols Item 3620190048.

2.09 PIPE BOLLARDS

- A. Fabricate pipe bollards from Schedule 40 steel pipe.

1. Cap interior bollards with 1/4-inch- minimum steel plate.
 2. Fill exterior bollards with concrete and cap with concrete crowned to provide drainage.
- B. Fabricate base plates for bollard anchorage from 1/4-inch thick steel plate welded to bottom of pipe.

2.10 FIXED STEEL LADDERS

- A. General: Fabricate ladders from steel components for locations shown, with dimensions as indicated.
- B. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges, spaced 24 inches apart.
- C. Bar Rungs: 3/4-inch diameter steel bars, spaced 12 inches o.c. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.
- D. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets. Size rungs and brackets to support design live loads of 200 pounds and as specified in ANSI A14.3.
- E. Intermediate Platform: Where ladder height exceeds 20-feet, provide 4'-0" x 6'-0" off-set platform landing fabricated from 1/4" steel diamond plate and 3" x 3" x 1/4" steel angle framing and wall braces. Provide 1 1/4" Schedule 40 pipe guard railings around perimeter of platform.

2.11 FIXED STEEL LADDER SAFETY CAGES

- A. General: Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding.
- B. Primary Hoops: 5/16-by-4-inch steel flat bar hoops. Provide at tops and bottoms of cages and spaced not more than 20 feet o.c.
- C. Secondary Intermediate Hoops: 5/16-by-2-inch steel flat bar hoops, spaced not more than 48 inches o.c. between primary hoops.
- D. Vertical Bars: 5/16-by-2-inch steel flat bars secured to each hoop, spaced approximately 9 inches o.c.

2.12 CAST-IN EMBED PLATES AND SHELF ANGLES

- A. General: Provide steel framing and supports that are not a part of structural-steel framework as necessary to complete the Work. Coordinate location and placement of embeds with approved tilt-panel submittals.
- B. Fabricate loose structural-steel embed plates from steel angles and shapes of size indicated for connection and support of site-cast tilt panels. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports.
1. Where units are indicated to be cast into concrete, provide integrally welded steel stud anchors of size and spacing as indicated.
- C. Fabricate shelf angles from steel angles of sizes indicated and for welded attachment to concrete embed plates.

2.13 COUNTERTOP SUPPORTS

- A. Horizontal Frame: Fabricate members from 2" x 2" x 1/4" steel tubing, welded to end-post supports. Field-verify post spacing requirements.
- B. End-Posts: Fabricate members from 2" x 3" x 1/4" steel tubing with 1/4" base plates. Configure base plate to be concealed in wall stud framing.

2.14 LOADING-DOCK DOOR CAST-IN EMBEDS

- A. Corner Guards: Fabricate channel-profile embeds from 4'-0" long x 3/16" steel plate, bent to conform to tilt-panel thickness, with welded studs at 16" o.c. vertically to be cast-in tilt-panel concrete. Locate bottom of plate guard to align with interior floor elevation.
- B. Floor Edge Angles: Fabricate members from 4" x 4" x 1/4" steel angle with 1/2" dia. x 4" long, welded head-studs at 16" o.c. horizontally to be cast-in floor slab concrete. Provide one-piece edge angles full length of dock door opening width.
- C. Floor Edge Channels: Fabricate members from C8 x 11.5 steel channels with 1/2" dia. x 4" long, welded head-studs at 16" o.c. horizontally to be cast-in floor slab concrete. Provide one-piece edge channels full length of dock door opening width.

2.15 STEEL PIPE GUARDRAILS

- A. Guardrails: Fabricate steel pipe guardrails to design, dimensions, and details indicated. Provide railings and handrails members formed of standard weight Schedule 40, 1 1/2-inch inside diameter pipe, but not less than that required to support design loading, and as follows:
 - 1. Railings may be bent at corners, rail returns and wall returns, in lieu of using prefabricated fittings.
- B. Brackets, Flanges, Fittings and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings and anchors for interconnections of pipe and attachment of railings to other work. Furnish inserts and anchorage devices for connecting railings to concrete or masonry.
 - 1. For railing posts set in concrete provide sleeves of galvanized steel pipe not less than 6" long and with an inside diameter not less than 1/2" greater than the outside diameter of pipe. Provide steel plate closure welded to bottom of sleeve and of width and length not less than 1" greater than outside diameter of sleeve.

2.16 CEILING HUNG OPERABLE PARTITION SUPPORTS

- A. Horizontal Frame: Fabricate concealed overhead rail support members from C8 x 11.5 steel channels suspended from floor structure above with adjustable all-thread supports spaced 3'-0" o.c. Brace rail horizontally with diagonal studs attached to structure above

2.17 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.18 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 153, for galvanizing steel and iron hardware.
- B. 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 1B): SSPC-SP 6, "Commercial Blast Cleaning."
- C. Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Paint corners, crevices, bolts, welds, and edges.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- B. Cutting, Fitting, and Placement: Perform field cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- D. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. At exposed connections, finish exposed welds and surfaces smooth so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

3.02 INSTALLING PIPE BOLLARDS.

- A. Anchor bollards in wet concrete footings to depth indicated. After bollards have been inserted, fill interior of bollard and sleeve solidly with concrete grout and slope grout up approximately 1/2 inch up to drain.

3.03 ANCHORING RAIL POSTS

- A. Form or core-drill holes not less than 6 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with non-shrink grout.
- B. Anchor posts to metal surfaces with square flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel pipe railings, weld flanges to post and bolt flange to metal supporting surfaces.

3.04 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 4.0-mil dry film thickness.

END OF SECTION

SECTION 06 10 50

ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Wood furring, grounds, nailers, and blocking.
 - 2. Plywood backing panels for millwork and equipment supports.
 - 3. Mounting boards for panel boards and telephone equipment.
- B. Related Sections include the following:
 - 1. Section 06 16 13 for "Sheathing" for exterior wall and soffit sheathing.

1.02 DEFINITIONS

- A. Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise indicated.
- B. Exposed Framing: Dimension lumber not concealed by other construction.

1.03 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Engineered wood products.
 - 2. 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, net amount of preservative retained, and chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
 - 3. 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, both before and after exposure to elevated temperatures when tested according to ASTM D 5516 and ASTM D 5664.
- B. Submit research or evaluation reports of the model code organization acceptable to authorities having jurisdiction that evidence the following products' compliance with building code in effect for Project.
 - 1. Engineered wood products.
 - 2. Power-driven fasteners.
 - 3. Powder-actuated fasteners.
- C. Shop Drawings: For engineered wood products, submit to Architect shop drawings showing layout, mark, number, type, location, and spacing of member. Include joining and anchorage details, bridging, bracing, accessories, and connection details and attachment to other units of work.

1.04 QUALITY ASSURANCE

- A. Identify each piece of lumber or plywood used for structural framing with grade and trademark of lumber grading organization.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.

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 any manufacturer that meets or exceeds the referenced standards listed in ICC-ES.

2.02 WOOD PRODUCTS, GENERAL

- A. Lumber: "Western Wood Products Association" (WWPA) for applicable rules of lumber grading.
- B. Inspection Agencies: West Coast Lumber Inspection Bureau (WCLIB).
- C. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
- D. Where nominal sizes are indicated, provide actual sizes required for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
 - 1. Provide dressed lumber, S4S, unless otherwise indicated.
 - 2. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 4-inch nominal thickness or less, unless otherwise indicated.

2.03 STRUCTURAL-USE PANELS

- A. Plywood Backing Panels: For mounting electrical or telephone equipment, provide plywood panels, grade C-D Plugged, Exposure 1, in not less than 23/32 inch thickness.
- B. Plywood Roof Deck Panels: At miscellaneous wall framing, provide plywood panels, grade C-D Plugged, Exposure 1, in not less than 23/32 inch thickness

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. Where rough carpentry fasteners are exposed to the exterior, provide fasteners with hot-dip zinc coating complying with ASTM A 153 or other non-corrosive coating.
- B. Power-Driven Fasteners: CABO NER-272.
- C. Wood Screws: ASME B18.6.1.
- D. Screws for Fastening to Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- E. Lag Bolts: ASME B18.2.1.
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Use screw-type fasteners, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.
- C. Install and secure framing members of size and at spacings indicated. Do not splice structural members between supports.

3.02 WOOD BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build anchor bolts into masonry during installation of masonry work. Where possible, secure anchor bolts to formwork before concrete placement.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.03 EQUIPMENT BACKER BOARDS

- A. General: Confirm equipment sizes, location and wall arrangement. Anchor plywood sheets to supporting construction, fastened 16 inches o.c., unless otherwise indicated.

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SECTION 06 16 13

SHEATHING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Wall and soffit sheathing.
 - 2. Above-roof parapet wall sheathing.
- B. Related Sections include the following:
 - 1. Section 06 10 50 for "Rough Carpentry" for interior plywood backer panels.
 - 2. Section 05 40 00 for "Cold-Formed Metal Framing" for sheathing supported by metal framing.
 - 3. Section 07 26 16 for "Self-Adhering Weather Barriers" for moisture-barriers applied over sheathing substrates.
 - 4. Section 07 42 13 for "Composite Metal Wall Panels" for metal panels over sheathing substrates.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C473 Standard Test Methods for Physical Testing of Gypsum Panel Products.
 - 2. ASTM C630 Standard Specification for Water-Resistant Gypsum Backing Board.
 - 3. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.

1.03 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Stack sheathing panels flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.01 WALL SHEATHING

- A. Glass-Mat Gypsum Wall and Soffit Sheathing: ASTM C 1177.
 - 1. Product: Subject to compliance with requirements, provide "Dens-Glass Gold" by G-P Gypsum Corporation.
 - 2. Type and Thickness: Type X, 5/8 inch thick.
 - 3. Size: 48 by 96 inches for vertical installation.
 - 4. Available Products:
 - a. Securock Glass-Mat; US Gypsum Co.
 - b. GlassRoc Sheathing; Certainteed Corp.
 - c. Gold Bond eXP; National Gypsum Co.

2.02 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified.
 - 1. Where fasteners are exposed to the exterior, provide fasteners with hot-dip zinc coating complying with ASTM A 153 or other non-corrosive coating.
- B. Screws for Gypsum Sheathing Panels to Metal Framing: Type W, bugle-head self-drilling steel screws, complying with ASTM C 1002, in length recommended by sheathing manufacturer for thickness of sheathing board to be attached, with corrosion-protective coating.
 - 1. For steel framing less than 0.0329 inch thick, attach sheathing to comply with ASTM C 1002.
 - 2. For steel framing from 0.033 to 0.112 inch thick, attach sheathing to comply with ASTM C 954.
- C. Screws for Cementitious Backer Panels to Metal Framing: Corrosion-resistant, 1 5/8 inch long, 8-ga. self-drilling steel screws, with wafer-head design for counter-sinking flush with panel face.

2.03 MISCELLANEOUS MATERIALS

- A. Building Paper: Asphalt-saturated organic felt complying with ASTM D 226, Type I (No. 15 asphalt felt), unperforated.
- B. Sheathing Joint Tape: 4-inch wide, glass-fiber reinforced tape.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Set sheathing panels to required levels and lines, with panel joints plumb, true to line, cut, and fitted. Adjust rough carpentry framing, furring, nailers, blocking, grounds, and similar supports as needed for accurate fit and support of panels and panel openings.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction, unless otherwise indicated.
- C. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- D. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- E. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or when rain is forecast.

3.02 GYPSUM SHEATHING INSTALLATION

- A. Comply with ASTM C 1280, Gypsum Association GA-253 and with manufacturer's written instructions.
 - 1. Fasten gypsum sheathing to metal framing with screws.
 - 2. Install boards with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
- B. Apply fasteners so heads bear tightly against face of sheathing boards but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent boards without forcing. Abut ends of boards over centers of studs, and stagger end joints of adjacent boards not less than one stud spacing. Attach boards at perimeter and within field of board to each steel stud.
 - 1. Space fasteners approximately 12 inches o.c. and set back a minimum of 1/2 inch from edges and ends of boards.

END OF SECTION

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SECTION 06 41 16

PLASTIC LAMINATE CLAD MILLWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Plastic-laminate casework.
 - 2. Plastic laminate countertops.
 - 3. Solid-surfacing-material countertops.

1.02 DEFINITIONS

- A. Exposed Portions of Cabinets: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches above floor, and surfaces visible in open cabinets.
- B. Semi-exposed Portions of Cabinets: Surfaces behind opaque doors, such as interiors of cabinets, shelves, dividers, interiors and sides of drawers, and interior faces of doors. Tops of cases 78 inches or more above floor are defined as semi-exposed.
- C. Concealed Portions of Cabinets: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, and ends and backs that are placed directly against walls or other cabinets.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Show field measurements and required locations of built-in supports or blocking.
- C. Samples: 12" x 12" for each exposed finish.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Fabricate casework, including countertops, fittings and accessories, through one source from a single manufacturer.
- B. Quality Standard: Cabinets and countertops shall comply with one of the following as directed by the Owner. Provide certification labels or compliance certificate indicating that woodwork complies with requirements of grades specified and directed.
 - 1. AWI Certification: Provide cabinets with AWI "Architectural Woodwork Quality Standards" for Custom Grade of interior architectural casework, construction, finishes, and other requirements.
- C. Regulatory Requirements:
 - 1. Comply with the following:
 - a. 2010 ADA "Standards for Accessible Design" and ADA Guidelines, as applicable.
 - b. 2018 International Building Code, Chapter 11.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver casework only after painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas.

- B. Keep finished surfaces covered with protective covering during handling and installation.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period. Ambient relative humidity must be maintained between 25 percent and 45 percent commencing prior to delivery.
- B. Field Measurements: Where casework is indicated to fit to other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating casework without field measurements.

1.07 COORDINATION

- A. Coordinate layout and installation of metal framing and reinforcements in gypsum board assemblies for support of institutional casework.

1.08 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 - 1. Delamination of components or other failures of glue bond.
 - 2. Warping of components.
 - 3. Failure of operating hardware.
 - 4. Deterioration or discoloration of finishes.
- B. Warranty Periods: (Years from date of Substantial Completion.):
 - 1. Materials and workmanship: 3 years.
 - 2. Structural failure of cabinet body: 5 years.
 - 3. Countertops: 2 years.

PART 2 - PRODUCTS

2.01 CUSTOM CABINETS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the named products or comparable products as prior approved.
 - 1. Plastic-Laminate: High-pressure decorative laminate complying with NEMA LD 3.
 - a. Cabinet Faces: Type VGS.
 - b. Cabinet Backer Sheet: Type BKL.
 - c. Countertops: Type HGS.
 - d. Semi-exposed interior cabinet surfaces: White melamine.
 - 2. Laminate Colors: As scheduled on Drawings.
- B. Maximum Moisture Content for Lumber: 7 percent for hardwood and 10 percent for softwood.
- C. Particleboard: ANSI A208.1, Grade M-2.
- D. Medium-Density Overlay Board: ANSI 208.2.
- E. Hardboard: AHA A135.4, Class 1 Tempered.
- F. Adhesives: Do not use adhesives or products made with adhesives that contain urea formaldehyde.

- G. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
- H. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality q³; not less than 3/8" thick.
- I. Glass for Glazed Countertops: Clear laminated glass complying with ASTM C 1172, Kind LT, Condition A, Type I, Class I, Quality q³; with 2 lites not less than 3.0 mm thick and with clear, polyvinyl butyral interlayer.
- J. Cabinet Design: Flush overlay.
- K. Cabinet Bases: Exterior grade plywood, individual factory applied, inset at ends and back. High-pressure laminate clad, complying with NEMA LD 3 matching door panels.
- L. Filler Strips and Utility-Space Closure Panels: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinet fronts.
- M. Hardware: Casework manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

2.02 CABINET FABRICATION

- A. Plastic-Laminate Cabinets: Comply with AWI Section 400 requirements for laminate cabinets.
 - 1. Bottoms and Ends of Cabinets, Shelves, and Tops of Wall Cabinets and Tall Cabinets: 3/4-inch particleboard, plastic-laminate faced on exposed surfaces, melamine faced on semi-exposed surfaces.
 - 2. Backs of Cabinets: 1/2-inch particleboard, plastic-laminate faced on exposed surfaces, melamine faced on semi-exposed surfaces.
 - 3. Drawer Fronts: 3/4-inch MDO, plastic-laminate faced on both sides.
 - 4. Drawer Sides and Backs: 1/2-inch melamine-faced particleboard, with glued dovetail or multiple-dowel joints.
 - 5. Drawer Bottoms: 1/2-inch melamine-faced particleboard glued and dadoed into front, back, and sides of drawers.
 - 6. Doors: 3/4-inch particleboard with wood stiles and rails, plastic-laminate faced on both sides.

2.03 COUNTERTOPS

- A. General: Provide smooth, clean exposed tops and edges in uniform plane free of defects. Provide front and end overhang of 1 inch over base cabinets.
- B. Plastic-Laminate Countertops: Comply with either AWI Section 400 requirements as applicable, for high-pressure decorative laminate countertops.
- C. Solid-Surfacing Tops: Fabricate tops in one piece with shop-applied backsplashes and edges, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
 - 1. Install integral sink bowls in countertops in shop.
 - 2. Drill holes in countertops for plumbing fittings in shop.

2.04 CABINET HARDWARE

- A. Hardware, General: Provide manufacturer's standard polished-finish, commercial-quality, heavy-duty hardware complying with requirements indicated.
 - 1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.

- B. Concealed Hinges: Nickel-plated, Euro-style, concealed overlay hinges, Provide 2 hinges for doors less than 48 inches high and 3 hinges for doors more than 48 inches high.
- C. Pulls: Solid chrome-plated brass wire pulls, fastened from back with two screws. For sliding doors, provide recessed chrome-plated flush-pulls. Provide 2 pulls for drawers more than 24 inches wide.
- D. Door Catches: Zinc-plated, dual, self-aligning, 7 pound permanent magnet catch. Provide 2 catches on doors more than 48 inches high.
- E. Drawer Slides: Epoxy coated, bottom mount, self-closing (last 3 inches of travel) drawer slides, designed to prevent rebound when drawers are closed, 3/4 extension.
 - 1. Box Drawer Slides: 100 lbf.
 - 2. File Drawer Slides: 100 lbf.
- F. Drawer, Cupboard, and Full Height Unit Locks: National lock 5 disc tumbler cam locks, brass with chrome-plated finish, unless otherwise noted.
 - 1. Lock core removable with a core key.
 - 2. All locks within a given room shall keyed alike with a single master.
 - 3. Provide locks on all doors and drawers.
- G. Adjustable Shelf Supports: 2-pin locking plastic shelf rests complying with BHMA A156.9, Type B04013.
- H. Silencers: For doors and drawers, provide 3/8" diameter self-adhesive nylon pads.

2.05 ACCESSORIES

- A. Adjustable Wall Shelf Supports: Surface-type steel standards and steel shelf brackets, with epoxy powder-coated finish, complying with BHMA A156.9, Types B04102 and B04112.

PART 3 – EXECUTION

3.01 CASEWORK INSTALLATION

- A. Install plumb, level, and true; shim as required, using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
 - 1. Where casework units stop short of other elements, provide flush matching filler panels vertically, across exposed tops and at wall cabinets, across bottoms.
 - a. Include spaces remaining when units of different depths have faces flush leaving voids behind the lesser depth unit.
- B. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Fasten cabinets to partition framing, wood blocking, or reinforcements in partitions with fasteners spaced 24 inches o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.
 - 1. Where base cabinets are not installed adjacent to walls, fasten to floor at toe space with fasteners spaced 24 inches o.c. Secure sides of cabinets to floor, where they do not adjoin other cabinets, with not less than two fasteners.
- C. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Align similar adjoining doors to a tolerance of 1/16 inch.
 - 1. Fasten through back, at top and bottom, at ends, and not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish or equal.
- D. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.02 COUNTERTOP INSTALLATION

- A. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.
- B. Field Jointing: Where possible, make in the same manner as shop jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop.
 - 1. Use concealed clamping devices for field joints in plastic-laminate countertops. Locate clamping devices within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten to exert a uniform heavy pressure at joints.
- C. Fastening:
 - 1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
- D. Provide required holes and cutouts for service fittings.
- E. Seal unfinished edges and cutouts in plastic-laminate countertops with polyurethane varnish.
- F. Provide scribe moldings for closures at junctures of countertop, curb, and splash, with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
- G. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.03 INSTALLATION OF ACCESSORIES

- A. Install accessories according to Shop Drawings and manufacturer's written instructions.
- B. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.
- C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

3.04 CLEANING AND PROTECTING

- A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- B. Protect countertop surfaces during construction with 6-mil plastic or other suitable water-resistant covering. Tape to underside of countertop.

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SECTION 07 11 10

BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Cold-applied, emulsified-asphalt dampproofing for vertical applications at the following conditions:
 - 1. Back-side of above-grade site and ramp retaining walls in contact with sub-grade fill.
 - 2. Back-side of below-grade site landscape planter and retaining walls in contact with landscape-fill.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.

1.03 QUALITY ASSURANCE

- A. Source Limitations: Obtain primary dampproofing coatings and primers through one source from a single manufacturer. Provide secondary materials compatible with primary coating materials.

PART 2 - PRODUCTS

2.01 COLD-APPLIED EMULSIFIED-ASPHALT DAMPPROOFING

- A. Manufacturers: ASTM D 1227, Type II, Class 1, semi-fibrated asphaltic emulsion for brush or spray-coat application with a VOC content of 0.25 lb/gal or less. Subject to compliance with requirements, provide products equal to one of the following:
 - 1. Henry 789; Henry Company.
 - 2. MasterSeal 615; BASF Corp
 - 3. Sealmastic; W.R. Meadows, Inc.

2.02 MISCELLANEOUS MATERIALS

- A. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, diluted as recommended by manufacturer.
- B. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.
- C. Patching Compound: Fibered mastic of type recommended by dampproofing manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates for compliance with requirements for surface smoothness and other conditions affecting performance of work.
 - 1. Test for surface moisture according to ASTM D 4263.

2. Begin dampproofing application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protection of Other Work: Mask or protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from clogging weep holes and drains.
- B. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by dampproofing materials manufacturer.
 1. Apply patching compound for filling and patching tie holes, honeycombs, reveals, and other imperfections, in accordance with Section 03 30 00 "Cast-in-Place Concrete".

3.03 DAMPPROOFING APPLICATION

- A. Comply with manufacturer's written recommendations unless more stringent requirements are required by Project conditions to ensure satisfactory performance of dampproofing.
 1. Apply additional coats if recommended by manufacturer to achieve coverages indicated.
 2. Allow each coat of dampproofing to cure six hours before applying subsequent coats.
 3. Allow 24 hours drying time prior to backfilling.
- B. Apply dampproofing to footings and foundation walls exposed to soil where opposite side of wall is exposed to interior of building or exterior above-grade conditions.
 1. Apply from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches over outside face of footing.
 2. Extend 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
 3. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints and cracks by embedding an 8-inch-wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing.
- C. Backside of Concrete Retaining Walls: Apply one brush or spray coat at not less than 1.5 gal./100 sq. ft.
- D. Backside of Masonry Retaining Walls: Apply primer and one brush or spray coat at not less than 2 gal./100 sq. ft.

3.04 INSTALLATION OF PROTECTION COURSE

- A. Install protection course over completed-and-cured dampproofing.
 1. Support protection course with spot application of adhesive of type recommended by protection board manufacturer over cured coating.

3.05 CLEANING

- A. Remove dampproofing materials from surfaces not intended to receive dampproofing.

END OF SECTION

SECTION 07 19 00

WATER-REPELLENT SEALER

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Clear, water-repellent coating for vertical masonry applications.
- B. Related Sections include the following:
 - 1. Division 4 Section 04 22 13 - "Concrete Unit Masonry" for integral sealers specified as part of concrete masonry mix fabrication.

1.02 SYSTEM DESCRIPTION

- A. Penetration: Water-repellent coating shall penetrate sufficiently to chemically bond with substrate. Cured coating shall resist penetration of water and water-borne salts.
 - 1. Water absorption on normal-weight split-face masonry vertical substrates shall not exceed 10% when tested according to ASTM E 514.
- B. Water-repellent coating shall not change surface texture, sheen, appearance or vapor permeability. Slight darkening of surfaces are acceptable only with approved mock-up application.

1.03 SUBMITTALS

- A. Product Data: Product descriptions and specifications, surface preparations and application instructions and coverage rates for each substrate.
- B. Certifications: Submit copies of test reports from independent testing laboratories.
- C. Warranty: Submit sample of manufacturers warranty and any special procedures required for warranty compliance.

1.04 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Provide documentation showing evidence of producing water-repellent coating material that has maintained water repellency for over 5 years of continuous field exposure.
- B. Applicator Qualifications: Approved by coating manufacturer and have a minimum of 2 years experience of successful application and performance
- C. Mock-Up Sample: Twenty-five (25) days prior to application on the Work, apply water-repellent coating to an 8-foot long sample wall using procedures and equipment defined in approved submittals.
 - 1. Mock-Up Water Penetration Test: Ten (10) days after application of water-repellent coating to sample wall, field water-test wall following procedures described in this Section.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect material containers from freezing or physical damage and from deterioration by moisture and other sources. Comply with manufacturers written instructions for handling and storage.

1.06 WARRANTY

- A. Manufacturers Warranty: Provide written warranty for a period of three (3) years from date of Substantial Completion that include the following provisions:
 - 1. Walls where water-repellent coating has been applied shall show no evidence of moisture penetration on interior surfaces for the full term of warranty period.
 - 2. Water-repellent coating shall not change surface color or texture for the full term of warranty period, regardless of number of coating applications required to comply with performance requirements.
 - 3. Warranty does not include water penetration at pin-holes or cracks in mortar joints or masonry substrates that exceed 1/32-inch in width.
- B. Applicator Warranty: Provide written guarantee for a period of three (3) years from date of Substantial Completion against poor workmanship or improper application of water-repellent coating.
- C. Remedial Repairs: Should water penetration occur on interior surfaces during the warranty period and is determined to be penetrating through water-repellent coating, manufacturer shall provide coating material and applicator shall make necessary repairs and reapplication of coating material at no cost to Owner.

PART 2 - PRODUCTS

2.01 WATER REPELLENTS

- A. Silane/Siloxane Blend: Penetrating water repellent compound, containing approximately 20 percent siloxane solids by weight, with alcohol, water, or other proprietary solvent carrier.
- B. Manufacturers: Furnish products of one of the following Manufacturers, subject to compliance with requirements of this Section:
 - 1. WeatherSeal Siloxane; ProSoCo, Inc.
 - 2. Blok-Lok; Rainguard Products Co.
 - 3. Protectosil Aqua-Trete EM; Evonik Industries.
 - 4. 303-S Siloxseal; Diedrich Technologies-Hoffman & Barnard Co.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.
 - 1. Verify that substrates have been cleaned and allowed to completely dry to moisture content acceptable to water-repellent coating manufacturer.
 - 2. Verify that exposed mortar joints have cured and have been uniformly tooled to a dense, concave surface. Repoint joints and allow to cure, where cracks or pin-holes exceed 1/32 inch in width.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrate of substances that might interfere with penetration or performance of water repellents. Test for moisture content, according to repellent manufacturer's written instructions, to ensure surface is sufficiently dry.

- B. Use suitable masking and all means necessary to protect metal, glass and other adjacent materials from water-repellent coating application. Immediately remove over-spray in the event of staining or damage.
 - 1. Protect sidewalks and other horizontal surfaces from over-spray and coating runoff by soaking with water until properly diluted.
- C. Coordination with Sealants: Do not apply water repellent until sealants for joints adjacent to surfaces receiving water-repellent treatment have been installed and cured.
 - 1. Water-repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent, and sealant materials identical to those used in the work.
- D. Preliminary Spray Test: Before a sealer application the following field test will be done. The cost of the field testing will be the responsibility of the water repellent manufacturer.
 - 1. Prepare a eight feet by three feet area to be sprayed with the water repellent. Apply the water repellent at a initial rate of 100 square feet per gallon.
 - 2. After water repellent has dried, spray coated surfaces with water. After surfaces have adequately dried, recoat surfaces that show water absorption.
 - 3. Allow five days for the sample to cure and run a RILEM uptake test on the treated area. Place one tube on the block and one tube on a mortar joint. Acceptable minimum results shall not exceed 10% water absorption. Coverage rates shall be adjusted to pass this test and adjusted rates shall be used on entire project.

3.03 APPLICATION

- A. General: Follow manufacturer's instructions for application methods and coverage rates for each substrate where water-repellent coating will be applied. Surfaces to receive water-repellent coating include:
 - 1. All exposed exterior masonry building walls.
 - 2. All exposed exterior masonry site walls, including both sides of screen walls, trash enclosure walls and planter walls.
 - 3. Other masonry locations as indicated on Drawings.
- B. Do not schedule coating application where substrate surface temperatures are or are expected to be below 40 degrees F.
- C. Application: Apply coating from bottom of wall progressively overlapping application towards top of wall, saturating surface, avoiding excessive run-down of coating material. Where multiple coats are applied, allow sufficient time between coats as recommended by manufacturer.
- D. Apply a heavy-saturation spray coating of water repellent on surfaces indicated for treatment using low-pressure (15 psi) airless spray equipment. Comply with manufacturer's written instructions for using airless spraying procedure, unless otherwise indicated. Product shall be applied as supplied by the manufacturer without dilution or alteration.
- E. Apply at a rate of not less than 100 square feet per gallon unless the field tests determine that a heavier rate of application is necessary to meet the performance requirements.
- F. Apply a second saturation spray coating, repeating first application methods, at a rate of not less than 200 square feet per gallon. Comply with manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats.

3.04 FIELD QUALITY CONTROL

- A. Water-penetration Test: Before installation of interior finishes or insulation has begun, a minimum area of 100 sq. feet of wall shall be tested. Notify Architect and Sealer Manufacturer 72 hours in advance of field test. Conduct test in the presence of Architect's and Manufacturer's representatives.

1. Provide equipment to support water-spray nozzle in a stationary position, aiming the nozzle so that water will strike the wall at a 45 degree downward angle and not over spray the top of site walls.
 2. Run water at full available pressure for a period of 2 hours. Upon completion of test inspect the back-side of walls for evidence of water penetration through wall. If water penetration is visible, repeat test on another portion of wall until satisfactory performance of sealer is obtained.
 3. Repair defective areas and retest until no water penetration occurs.
- B. Water Uptake Test: Within 24 hours of water-spray field test, perform a RILEM Water Uptake test on a minimum of 10 locations on the tested areas to confirm conformance to minimum results stated herein. Conduct test on upper and lower portions of the masonry surfaces and on an equal number of joints and block surfaces. Tests shall be conducted by the manufacturer's representative.
- C. Furnish written certification that surface preparation and rate of application is completed in accordance with specification requirements and the manufacturer's recommendations. Furnish results of in-place RILEM and water-spray test.

3.05 PROTECTION

- A. Protection: Protect masonry surfaces while coating is still wet and susceptible to damage or discoloration from dust, wind-blown debris or rain.

END OF SECTION

SECTION 07 21 16

BUILDING INSULATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Concealed building insulation.
 - 2. Curtainwall insulation.
- B. Related Sections include the following:
 - 1. Section 07 54 23 for "Single-Ply Membrane Roofing" for above-deck insulation specified as part of roofing membrane assembly, if any.

1.02 REFERENCES

- A. ASTM International (ASTM)
 - 1. ASTM C 665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include r-value certifications and fire-resistive ratings.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of building insulation through one source.
- B. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface-Burning Characteristics: ASTM E 84.
 - 2. Fire-Resistance Ratings: ASTM E 119.
 - 3. Sound-Transmission Class: ASTM C 423.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.01 INSULATING MATERIALS

- A. General: Provide insulating materials that comply with requirements and with referenced standards.

- B. Unfaced Mineral-Fiber Blanket Insulation: ASTM C 665, Type I, Class A, glass fiber batts; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics. Provide single thickness batts, for stud-wall locations as indicated, to provide thermal-resistance values as follows:
 - 1. Overall R-Value (2" x 4" perimeter wall framing): R-13.
 - 2. Overall R-Value (2" x 8" interior demising wall framing): R-19
- C. Unfaced, Glass-Fiber Acoustic Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indices of 10 and 10, respectively; and of the following properties:
 - 1. STC Rating: 46.
 - 2. Nominal Density: 1.5 lb/cu. ft.
 - 3. Thickness: 3 1/2 inches.
 - 4. Acceptable Product: Sound Attenuation Batts; Owens-Corning, Inc.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Do not install insulation until protected from weather that will not damage or wet the insulation.
- B. 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.
- C. Fully insulate small and non-standard size spaces by carefully cutting and fitting insulation material to maintain continuity of insulation.

3.03 CAVITY WALL INSTALLATION

- A. Install mineral-fiber blankets in cavities formed by framing members according to the following requirements:
 - 1. Use blanket widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
 - 2. Place blankets in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 3. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping stapling flanges to flanges of metal studs.

3.04 PROTECTION

- A. Protect installed insulation and facing membranes 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 07 24 16

WATER-DRAINAGE EXTERIOR INSULATION and FINISH SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Water-drainage barrier, polymer-based exterior insulation and finish system (EIFS) adhesively applied over sheathing.
- B. Related Sections include the following:
 - 1. Section for 05 40 00 for "Cold Formed Metal Framing" for metal framing support of sheathing.
 - 2. Section 06 16 00 for "Sheathing" for application of sheathing board materials.
 - 3. Section 07 92 00 for "Joint Sealants" for application of sealants to adjacent materials.

1.02 SYSTEM PERFORMANCE

- A. Installation: Application of the exterior insulation finish system shall be as specified herein and in accordance with the Manufacturer's printed instructions, ASTM C1397 "Standard Practice for Application of Class PB Exterior Insulation and Finish Systems" and comply with the following performance characteristics:
 - 1. Bond Integrity: Free from bond failure within EIFS components or between system and supporting wall construction, resulting from exposure to fire, wind loads, moisture, or other in-service conditions.
 - 2. Water-Drainage: Designed and installed in compliance with ICC-ES AC235, resistant to water penetration through EIFS system with an integral means that allows the EIFS assembly to drain to the exterior and protects substrates assemblies behind it, supporting wall construction, and interior finish from moisture deterioration or other degradation.
- B. Insulation Board:
 - 1. Moisture Protection: At all locations and edges, insulation board shall be completely covered by reinforcing mesh and adhesive layer base or finish coat applied where exposed to the exterior.
 - 2. Fire-Resistance: Separate insulation board from interior of building with minimum 5/8 inch gypsum sheathing or equivalent fire-resistive barrier which will limit the unexposed surface temperature of the insulation board to not more than 250 degrees after 15 minutes of interior fire exposure when tested in accordance with ASTM E 119.
- C. Expansion Control Joints:
 - 1. Substrate: Where substrate changes in direction of plane or joints occur.
 - 2. Other Materials: Where EIFS system abuts other materials.
 - 3. Movement: Where thermal or structural movement exceeding 1/8 inch will occur.

1.03 SUBMITTALS

- A. Product Data for each product specified.
- B. Samples: Provide color and texture samples for approval.
 - 1. 12 inch square samples showing the full range of colors, textures, for each type of finish.
- C. Material Certificates: Submit certificates indicating ICBO approvals of EIFS system and moisture-barrier.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. EIFS System: Approved in current ICBO report, acceptable to municipality of jurisdiction.
 - a. Senergy, BASF; ICC-ESR-1878
 - b. STO Industries. ICC-ESR-1030
 - c. Dryvit Systems, Inc. ICC-ESR-1821
 - 2. Insulation Board: Listed in the U.L. Design Materials Directory as having a flame-spread rating not greater than 25 and a smoke-developed rating not greater than 450 when tested per ASTM E84.
- B. Quality Assurance: Work of this Section shall be in accordance with the following:
 - 1. Approved Applicators: Application of EIFS materials shall be performed by applicators approved by the Manufacturer.
 - 2. Construction Document Compliance: Applicator shall review EIFS system application conditions and details indicated on the Drawings for compliance with Manufacturers approved application details and shall provide a written summary of recommendations required by the Manufacturer to qualify the installation for the EIFS system warranty.
 - 3. Special Inspections: Establish procedures and a schedule for a quality assurance inspection program in compliance with municipal code requirements.
- C. Pre-Installation Conference: Schedule a pre-installation conference at least 10 days prior to start of Work to review exterior insulation and finish system procedures.
 - 1. Attendees: Authorized representatives of the Architect, Contractor, E.I.F.S. installer, E.I.F.S. manufacturer's representative, Owner and other trades relevant to the work shall attend.
 - 2. Agenda: Discuss and document items of concern, including the following:
 - a. Review of Construction Documents by all parties present of the latest approved documents.
 - b. Coordination of E.I.F.S. applicator's Work with other work which connects with, is adjacent to, or will be concealed by Work of this Section.
 - c. Environmental requirements and proposed protection procedures as Work progresses.
 - d. Schedule of required quality assurance inspections.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original packages, containers, labeled with manufacturer's name.

1.06 PROJECT CONDITIONS

- A. Weather Limitations: Do not apply materials when temperature is below 40 deg F. Do not apply EIFS adhesives or coatings for a minimum of 24 hours after rainfall. Proceed with installation only when existing and forecasted weather conditions and ambient outdoor air, humidity, and substrate temperatures permit EIFS to be applied, dried, and cured according to manufacturers' written instructions and warranty requirements.
- B. Protect other work from staining and other deterioration caused by EIFS application. Provide temporary covering and other provisions necessary to prevent harmful spattering of material on other work.

1.07 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. Finish Coat: Provide 5-gal containers of each color.

1.08 WARRANTY

- A. Provide manufacturer's five-year warranty covering labor and materials used in finish system and substrate.

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 the following:
 - 1. Senergy, BASF Construction Chemicals, LLC.
 - 2. STO Industries.
 - 3. Dryvit Systems, Inc.
- B. Basis-of-Design are based upon products as manufactured by Senergy.

2.02 MATERIALS

- A. Compatibility: Provide water-resistive barrier, adhesive board insulation, reinforcing mesh, base and finish-coat systems, sealants, and accessories that are compatible with one another and with substrates as approved for use by EIFS manufacturer for Project.
- B. Water-Resistive Barrier Coating: EIFS manufacturer's pre-mixed liquid formulation (Senersshield-R) for use as a water-resistive barrier, compatible with glass-mat faced gypsum board substrate, and complying with physical and performance criteria of ICC-ES AC212.
 - 1. Sheathing Joint Compound and Tape: Type recommended by EIFS manufacturer for sealing joints between and penetrations through sheathing.
- C. Insulation Adhesive: EIFS manufacturer's standard formulation designed for indicated use; compatible with substrate; and complying with the following:
 - 1. Factory-mixed non-cementitious formulation designed for adhesive attachment of insulation to substrates of type indicated, as recommended by EIFS manufacturer.
- D. Channeled Insulation Board: Expanded polystyrene, ASTM C578, Type I, air dried for a period of not less than 6 weeks before use.
 - 1. Drainage Channel Dimensions: Depth and spacing per manufacturer for vertical drainage.
 - 2. Flame Spread (ASTM E84 or UL 723): Less than 25.
 - 3. Average Density: 1.0 pound per cubic foot.
 - 4. K-value: 0.23 per inch.
 - 5. Thickness: Not less than one and one-half inch or as indicated.
 - 6. Maximum Board Size: 24 inches x 48 inches.
- E. Reinforcing Mesh: Balanced, alkali-resistant, open-weave, glass-fiber mesh treated for compatibility with other EIFS materials, made from continuous multiend strands with retained mesh tensile strength of not less than 120 lbf/in. per ASTM E 2098; complying with ASTM D 578 and the following:
 - 1. Standard-Impact Reinforcing Mesh: Not less than 4.0 oz./sq. yd.
 - 2. Heavy-Duty Reinforcing Mesh: Not less than 20 oz./sq. yd..
- F. Base-Coat Materials: EIFS manufacturer's standard job-mixed formulation of portland cement complying with ASTM C 150, Type I, white or natural color; and manufacturer's standard polymer-emulsion adhesive designed for use with portland cement-based materials.
- G. Primer: EIFS manufacturer's standard factory-mixed, elastomeric-polymer primer for preparing base-coat surface for application of finish coat.
- H. Flexible-Membrane Flashing: Cold-applied, fully self-adhering, self-healing, rubberized-asphalt and polyethylene-film composite sheet or tape and primer; EIFS manufacturer's standard or product recommended in writing by EIFS manufacturer.
- I. Finish-Coat Materials: EIFS manufacturer's standard acrylic-based coating complying with the following:
 - 1. Factory-mixed formulation of polymer-emulsion binder, colorfast mineral pigments, sound stone particles, and fillers.

2. Sealer: Manufacturer's waterproof, clear acrylic-based sealer for protecting finish coat.
 3. Colors: Custom colors as indicated on Drawings.
- J. Trim Accessories: Type as designated or required to suit conditions indicated and to comply with EIFS manufacturer's written instructions; manufactured from UV-stabilized PVC; and complying with ASTM D 1784, manufacturer's standard Cell Class for use intended, and ASTM C 1063.
1. Drip Screed/Track: Prefabricated, one-piece type for attachment behind insulation with face leg extended to form a drip, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg.
 2. Weep Screed/Track: Prefabricated, one-piece type for attachment behind insulation with perforated face leg and weep holes in track bottom, of depth required to suit thickness of coating and insulation, with face leg perforated for bonding to coating and back leg; designed to drain incidental moisture that gets into wall construction to the exterior at terminations of EIFS with drainage.
 3. Sill Flashing: Prefabricated type for both flashing and sloping sill over framing beneath windows; with end and back dams; designed to direct water to exterior.

2.03 PROPORTIONS AND MIXING

- A. General: Comply with ASTM C 926 for base-coat and finish-coat mixes as applicable to bases, materials, and with EIFS manufacturer's requirements for combining and mixing materials. Do not introduce admixtures, water, or other materials except as recommended by EIFS manufacturer. Mix materials in clean containers. Use materials within time period specified by EIFS manufacturer or discard.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, roof edges, wall framing, flashings, openings, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, sheathing attachment and other conditions affecting performance of EIFS.
- B. Exterior Gypsum Board Sheathing Installation:
1. Verify that surfaces of sheathing do not vary from more than 1/4 inch from the plane of faces of adjacent surfaces.
 2. Sheathing is attached to framing with screws spaced 8 inches o.c.
 3. Fasteners are driven so as to bear flush with surface of sheathing.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
1. Begin coating applications only after surfaces are dry.
 2. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

- A. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection to prevent spattering of exterior finish coats on other work.
- B. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind drainage plane of EIFS and deterioration of substrates.
- C. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

3.03 SUBSTRATE PROTECTION APPLICATION

- A. Water-Resistive Barrier Coating: Apply over substrates to protect sheathing substrates from degradation and to provide water-resistive drainage barrier.
 - 1. Tape and seal joints, exposed edges, terminations, and inside and outside corners of sheathing unless otherwise indicated by EIFS manufacturer's written instructions.
 - 2. Spray- or roller-apply to a minimum wet film thickness of 10 mils. Back-roll application to ensure coating is free of voids or pin-holes.

3.04 TRIM INSTALLATION

- A. Trim: Apply trim accessories at perimeter of EIFS, at expansion joints, and elsewhere as indicated, according to EIFS manufacturer's written instructions.
 - 1. Drip Screed/Track: Use at bottom edges of EIFS unless otherwise indicated.
 - 2. Expansion Joint: Use where indicated on Drawings.
 - 3. Casing Bead: Use at vertical edges of EIFS unless otherwise indicated.

3.05 EIFS INSTALLATION

- A. General: Apply materials, composition, and mixes to comply with ASTM C 1397, "Standard Practice for Application of Class PB Exterior Insulation and Finish Systems" for installation of EIFS as applicable to each type of substrate indicated.
- B. Board Insulation Installation: Adhesively attach insulation boards, and mechanically attach foam shapes exceeding 4-inches in depth, to substrate as follows:
 - 1. Apply adhesive to the interior face of insulation by trowel method in a manner that keeps the insulation drainage channels free of adhesive.
 - 2. Apply adhesive to water-resistive barrier substrate with 3/8-inch notched-trowel or other means to produce vertical ribbons of adhesive spaced approximately 2-inches apart.
 - 3. Press insulation into place, applying pressure over the entire surface of insulation to accomplish uniform contact and overall level surface. Do not slide insulation in place to avoid blocking of drainage channels.
 - 4. Allow adhered insulation to remain undisturbed for period recommended by EIFS manufacturer, but not less than 12 hours, before beginning rasping and sanding insulation, or applying base coat and reinforcing mesh.
 - 5. Apply insulation over substrates in courses with long edges of boards oriented horizontally and drainage channels oriented vertically.
 - a. Stagger vertical joints of insulation boards in successive courses to produce running bond pattern. Locate joints so no piece of insulation is less than 12 inches wide or high. Offset joints not less than 6 inches from sheathing joints.
 - 6. Pre-cut insulation board to fit openings, corners, and projections precisely and to produce edges and shapes complying with details indicated.
 - 7. Cut aesthetic reveals in outside face of insulation with router and bit configured to produce profiles and locations indicated. Do not reduce insulation thickness at reveals to less than 3/4 inch.
 - 8. Treat exposed edges of insulation as follows:
 - a. Encapsulate edges forming substrates of sealant joints within EIFS or between EIFS and other work with base coat and reinforcing mesh.
 - 9. Coordinate installation of flashings and insulation to produce wall assembly that does not allow water to penetrate behind flashing and EIFS protective-coating.
- C. Base Coat Installation: Apply to exposed surfaces of insulation and foam shapes in minimum thickness recommended in writing by EIFS manufacturer, but not less than 1/16-inch dry-coat thickness.
 - 1. Reinforcing Mesh: Embed standard-impact reinforcing mesh in wet base coat to produce wrinkle-free installation with mesh continuous at corners and overlapped not less than 4 inches. Completely embed mesh, applying additional base-coat material if necessary, so reinforcing-mesh is not visible.
 - 2. Additional Reinforcing Mesh: Apply strip reinforcing mesh not less than 12 inches wide.
 - a. At reveals, embed reinforcing mesh in base coat.

- b. At corners, embed strip reinforcing mesh at both inside and outside corners.
 - c. At openings, apply strip reinforcing mesh around openings extending 4 inches beyond perimeter. Apply additional 12-inch strip reinforcing mesh diagonally at corners of openings.
- 3. Foam Shapes: Fully embed reinforcing mesh in base coat.
- D. Finish Coat Application: Apply over dry base coat, maintaining a wet edge at all times for uniform appearance, in thickness required to produce a uniform finish of color and texture matching approved sample and free of cold joints, shadow lines, and texture variations.
 - 1. Mask-off to protect all door and window frames, penetrations, railings, flashings, concrete walks and steps, electrical equipment and fixtures and other similar items during application.
 - 2. Apply finish coat in one application to the entire wall surface of each wall in the same plane by one applicator to achieve uniform finish top to bottom of wall. Take special care to avoid lap marks at floor lines and scaffold runs.
 - 3. Finish Texture: To match approved samples or mock-ups. Embed aggregate in finish coat according to EIFS manufacturer's written instructions to produce a uniform applied-aggregate finish of color and texture matching approved sample.
- E. Prepare joints and apply sealants, of type and at locations indicated, to comply with applicable requirements in Section for "Joint Sealants" and to produce a weather-tight installation while maintaining internal drainage of EIFS system to exterior.
 - 1. Apply masking tape before sealant application to protect areas adjacent to sealant joints. Remove tape immediately after tooling joints, without disturbing joint seal.
 - 2. Clean surfaces to receive sealants to comply with EIFS manufacturer's written instructions.
 - 3. Apply primer after base coat has cured and as recommended by sealant manufacturer for surfaces to be sealed.
 - 4. Install sealant backing to control depth and configuration of sealant joint and to prevent sealant from adhering to back of joint. Recess sealant sufficiently from surface of EIFS so sealant application, including cylindrical sealant backing, can be installed without protruding beyond EIFS surface.

3.06 CUTTING AND PATCHING

- A. Cut, patch, replace and repair, as necessary to accommodate other work. Repair cracks and indented surfaces. Repair or replace work to eliminate blisters, buckles, checks or cracking, efflorescence, pinholes, and similar defects. Repair or replace work to comply with finish of approved mock-up samples.

3.07 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
 - 1. According to ICC-ES AC219 and in accordance with local municipal code requirements.
- B. Remove and replace EIFS where test results indicate installation does not comply with requirements.

3.08 CLEANING AND PROTECTING

- A. Remove temporary covering and other provisions made to protect other work. Promptly remove finish materials from other surfaces not intended to receive finish materials. Repair surfaces stained, marred or otherwise damaged from EIFS work. When work is completed, remove unused materials, containers, equipment, and debris.

END OF SECTION

SECTION 07 26 13

WEATHER BARRIERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Concealed weather barrier membrane over gypsum sheathing substrates.
- B. Related Sections include the following:
 - 1. Section 06 16 00 – “Sheathing” for gypsum sheathing installation.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated. Include r-value certifications and fire-resistive ratings.

1.03 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of membrane material and accessory products through one source.
 - 1. Installer shall have experience with installation of weather barrier assemblies under similar applications.
 - 2. Installation shall be in accordance with weather barrier manufacturer's installation guidelines and recommendations.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Protect 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.

1.05 SCHEDULING

- A. Review requirements for sequencing of installation of weather barrier assembly with installation of windows, doors, louvers and flashings to provide a weather-tight barrier assembly.

1.06 WARRANTY

- A. Weather barrier manufacturer's warranty for weather barrier for a period of five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Basis of Design: Polyethylene, non-woven, non-perforated, secondary weather barrier with textured surface to provide drainage of surface moisture and moisture vapor.

1. Tyvek CommercialWrap D; DuPont.
- B. Performance Characteristics:
 1. Air Penetration: 0.004 cfm/sf at 75 Pa, when tested in accordance with ASTM E 2187.
 2. Water Vapor Transmission: 30 perms, when tested in accordance with ASTM E 96, Method B.
 3. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E 84 . Flame Spread: 15, Smoke Developed: 25.

2.02 ACCESSORIES

- A. Seam Tape: 3-inch wide proprietary tape.
- B. Fasteners: 1-5/8 inch corrosion-resistant screw with 2-inch diameter plastic fastener cap.
- C. Sealants: Provide sealants that comply with ASTM C 920, elastomeric polymer sealant to maintain watertight conditions.
- D. Adhesives: Provide adhesive recommended by weather barrier manufacturer.
- E. Primers: Provide primer to assist in adhesion between substrate and flashing.
- F. Flashing
 1. Flexible Membrane Flashing: Manufacturers approved materials for window openings and penetrations.
 2. Thru-Wall Surface Adhered Membrane with Integrated Drip Edge: Thru-Wall flashing membrane materials for flashing at changes in direction or elevation and at transitions between different assembly materials.
 3. Preformed Corners and End Dams: Preformed three-dimensional shapes to complete the flashing system used in conjunction with thru-wall flashing.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install weather barrier over exterior face of exterior wall substrate in accordance with manufacturer recommendations.
- B. Start weather barrier installation at a building corner, leaving 6-12 inches of weather barrier extended beyond corner to overlap.
 1. Install weather barrier in a horizontal manner starting at the lower portion of the wall surface with subsequent layers installed in a shingling manner to overlap lower layers. Maintain weather barrier plumb and level.
 2. Seal seams of weather barrier with seam tape at all vertical and horizontal overlapping seams.
 3. Seal any tears or cuts as recommended by weather barrier manufacturer.
- C. Base Flashing Interface: Extend lower edge of weather barrier over sill flashing interface 6 inches. Secure with elastomeric sealant as recommended by weather barrier manufacturer.
- D. Weather Barrier Attachment:

1. Attach weather barrier to stud framing through exterior sheathing. Secure using weather barrier manufacturer recommend fasteners, space 18 inches vertically on center along stud line, and 24 inch on center, maximum horizontally.
- E. Thru-Wall Flashings: Install adhesive type flashings as recommended by membrane manufacturer that are compatible with substrates encountered. Lap and seal flashings to provide a water-tight installation.

3.03 PROTECTION

- A. Protect installed weather barrier membrane from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary protection where membrane is subject to damage or puncture and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

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SECTION 07 26 26

UNDER-SLAB VAPOR BARRIERS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes under-slab-on-grade, sheet-type, vapor barrier membrane.
- B. Related Work in other Sections includes the following:
 - 1. Section 03 30 00 – “Cast-in-Place Concrete” for coordination with slab-on-grade concrete installation.

1.02 PERFORMANCE REQUIREMENTS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM E 1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
 - 2. ASTM E 96 - Standard Test Methods for Water Vapor Transmission of Materials.
 - 3. ASTM E 1643 - Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- B. American Concrete Institute (ACI)
 - 1. ACI 302.2R-06 - “Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials”.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's product data, manufacturer's printed instructions for installation, preparing, and treating penetrations, and other limitations of installation conditions.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Handle materials in accordance with manufacturer's recommendations. Remove material from Project that have been punctured or otherwise damaged.

1.05 WARRANTY

- A. Installation Warranty: Provide Installer's 2 year warranty from date of Substantial Completion, to include all components of the vapor-barrier membrane installation, against failures including loss of membrane seal and moisture penetration through vapor retarder membrane, beyond specified limits.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Plastic Sheet Vapor Barrier: Multi-ply laminated, low-density polyethylene plastic, reinforced membrane, formed into uniform, flexible sheets. Provide related accessories including seam tape, mastic and sealant recommended by manufacturer. Subject to compliance with requirements, provide one of the following:
 - 1. Perminator; W.R. Meadows.

2. Vaporguard; Reef Industries, Inc.
3. Stego Wrap Vapor Barrier; Stego Industries.

2.02 MATERIALS

- A. Plastic Vapor Barrier: Vapor barrier membrane must meet or exceed requirements of ASTM E 1745, Class A, and the following properties:
 1. Maximum Permeance: 0.01 Perms or less.
 2. Membrane Thickness: Not less than 15 mils.

2.03 ACCESSORIES

- A. Seam Tape: Polyethylene tape with pressure sensitive adhesive. Minimum tape width of 6 inches.
- B. Penetration Mastic: Manufacturer's recommended, water-based, elastomeric emulsion, suitable for sealing of vapor barrier membrane penetrations.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Level and compact sub-base material or sub-grade to provide minimum concrete slab thicknesses as indicated.
- B. Proceed with membrane installation only after sub-base aggregates are dry and unsatisfactory conditions have been corrected.

3.02 APPLICATION

- A. General: Installation shall be in accordance with manufacturer's instructions and ASTM E 1643.
 1. Minimize lineal quantity of seams by placing vapor barrier with the longest dimension parallel with the longest dimension of perimeter building walls.
 2. Extend vapor barrier to the perimeter of the slab or other vertical terminations. At the point of termination, seal vapor barrier to the perimeter wall or slab using double-sided or textured tape as recommended by manufacturer.
 3. Lap vapor barrier over interior column footings and seal to column flanges.
 4. Overlap seam joints 6" and seal with manufacturer's seam tape.
 5. Seal all conduit and pipe penetrations with manufacturer's tape and/or mastic.
 6. Where reinforcing bar is installed, use support chairs with feet or base-plate sections that prevent the puncture of the vapor barrier membrane.
 7. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 12" and taping and sealing all four sides in the same manner as lap seams.
 8. Do not cover membrane with sand cushion or aggregate sub-base material. Concrete shall be placed directly in contact with membrane.

3.03 FIELD QUALITY CONTROL

- A. Membrane Inspection: Arrange for membrane system manufacturer's technical personnel to inspect installation as work progresses and on completion and submit reports to Architect.

END OF SECTION

SECTION 07 42 13

COMPOSITE-METAL WALL PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Composite aluminum sheet wall and soffit panels and matching sheet fascia-trim.
- B. Related Sections include the following:
 - 1. Section 05 40 00 "Cold-Formed Metal Framing" for secondary support framing supporting metal cladding panel subgirt framing components.
 - 2. Section 07 62 00 "Sheet Metal Flashing and Trim" for fascia, copings, flashings and other sheet metal work not part of metal cladding panel assemblies.
 - 3. Section 07 92 00 "Joint Sealants" for field-applied sealants not otherwise specified in this Section.

1.02 COMPONENTS OF THE WORK

- A. General: Contractor shall design, engineer, fabricate, deliver and install a system of metal panel cladding components necessary to provide a complete and weathertight enclosure of the building and fenestration elements indicated on the Contract Documents, including all additional measures necessary for the proper performance of the metal cladding system, notwithstanding any omissions or inadequacies shown or not shown on the Contract Documents.
- B. Aluminum Panel System: PVDF coil-coated, composite aluminum sheet clad panels of 1/4-inch minimum thickness, mechanically attached to a subgirt support framing system. Elements of the Work include:
 - 1. Exterior high-roof shade canopy fascia and soffit cladding;
 - 2. Exterior wall cladding.

1.03 DEFINITIONS

- A. Metal Panel Assembly: Pre-finished metal wall or soffit panels, attachment system components, miscellaneous metal framing, and accessories necessary for a complete weathertight system.
- B. Metal Fascia Trim: Light gauge aluminum sheet, fabricated to profiles to complete metal panel assembly enclosures, attachment components, miscellaneous metal framing, and accessories necessary for a complete weathertight system.
- C. Water Leakage: Uncontrolled water infiltrating the system or appearing on system's interior surfaces from sources other than condensation. Water controlled by flashing and gutters that is drained back to the exterior and cannot damage adjacent materials or finishes is not considered water leakage.

1.04 PERFORMANCE REQUIREMENTS

- A. General: Provide metal panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.
- B. Water Penetration: No evidence of water leakage when tested according to ASTM E 331 under test-pressure equal to inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft.

- C. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of wall area when tested according to ASTM E 283 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 1.57 lbf/sq. ft.
- D. Structural Performance: Provide metal panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated, based on testing according to ASTM E 330:
 - 1. Wind Loads: Determine loads based on the following minimum design wind-load design pressures indicated in the General Structural Notes, but not less than:
 - a. Uniform pressure of 10 lbf/sq. ft., acting inward or outward.
 - 2. Deflection Limits: Engineer metal panel assemblies to withstand test pressures with deflection no greater than 1/240 of the span and no evidence of material failure, structural distress, or permanent deformation exceeding 0.2 percent of the clear span.
 - a. Test Pressures: 150 percent of inward and outward wind-load design pressures.
- E. Thermal Movements: Provide metal panel assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing oil-canning, buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Range: 125 deg F, ambient; 180 deg F, material surfaces.

1.05 SUBMITTALS

- A. Product Data: Include joint details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal wall panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
 - 1. Accessories: Include details of the following items:
 - a. Flashings, copings and trim.
 - b. Terminations to adjacent construction.
 - c. Support sub-framing.
 - d. Wall-mounted items including doors, windows, louvers, and lighting fixtures.
- C. Samples: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Panels: 12 inches square. Include fasteners, closures, and other metal panel accessories. Include four-way joint for metal panel system.
 - 2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
- D. Compatibility and Adhesion Test Reports: For wet-sealed panel systems, indicating the materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants.
- E. Research/Evaluation Reports: For metal panel system.
- F. Warranties: Special warranties specified in this Section.

1.06 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Fabricator of metal-faced wall panels.
 - 1. Engineering Responsibility: Preparation of data for metal panels, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and meeting the performance requirements specified.
- B. Installer Qualifications: Certified by metal panel manufacturer to fabricate and install manufacturer's panel system.

1. Installer's responsibilities include fabricating and installing metal panel sub-assemblies and providing professional engineering services needed to assume engineering responsibility.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal wall panels and are based on the specific system indicated.
 1. Do not modify intended aesthetic effects, except as subsequently approved on submittals. If modifications are proposed, submit comprehensive explanatory data with initial submittal.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping. Protect strippable protective covering on metal panels from exposure to sunlight and high humidity, except to extent necessary for period of metal panel installation.

1.08 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.

1.09 COORDINATION

- A. Coordinate metal panel assemblies with rain drainage work, flashing, trim, and construction of support framing, soffits, and other adjoining work to provide a leak-proof, secure, and non-corrosive installation.

1.10 WARRANTY

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

PART 2 - PRODUCTS

2.01 PANEL MATERIALS

- A. Aluminum Sheet: Coil-coated sheet, ASTM B 209, alclad alloy 3003, 3004, or 3105 for painted finishes and alloy 5005 for anodic finishes with temper as required to suit forming operations and structural performance required.
 - 1. Surface: Smooth, flat finish.
- B. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by manufacturer for type of use and finish indicated.

2.02 METAL-FACED COMPOSITE PANELS

- A. General: Provide factory-formed and pre-assembled metal-faced composite fascia or soffit panels fabricated from two metal facings bonded, to thermoplastic core; with reveals formed into routed bent-return profile for concealed fastener, dry-joint installation method. Include attachment system components and accessories required for weathertight system. The design of aluminum wall panel systems are based on Alpolic/PE ACM Panel System as manufactured by Mitsubishi Composites.
- B. Aluminum-Faced Composite Wall Panels: Formed with 0.020-inch- thick, coil-coated painted aluminum sheet facings.
 - 1. Panel Composite Thickness: 0.236 inch (6mm).
 - 2. Core: Solid polyethylene.
 - 3. Exterior Finish: PVDF Fluoropolymer
 - a. Color: BGY Gary
- C. Attachment System Components: Formed from extruded aluminum.
 - 1. Provide internal drainage system and allow individual panels to "free float" and be installed and removed without disturbing adjacent panels.
 - 2. Include manufacturer's standard subgirts, perimeter extrusions, tracks, and drainage channels, panel stiffeners, panel clips and anchor channels.
 - 3. Alignment Pins: Stainless steel.
 - 4. Flashing and Trim: Same material, finish, and color as adjacent composite panels, minimum 0.030 inch thick, unless otherwise indicated.

2.03 ELASTOMERIC SHEET UNDERLAYMENT

- A. Sheet Membrane Underlayment: SBS-modified bituminous, high-temperature resistant, self-adhering, laminated polyethylene sheet membrane, minimum 40 mils thick.
 - 1. Acceptable Products: Lastobond Shield HT; Soprema, Inc.
 - 2. Polyguard HT; Polyguard Products.
 - 3. Grace Ultra; Grace Construction Products.
- B. Sheet Flashing Membrane: Uncured neoprene or EPDM self-adhering sheet flashing, ASTM D 4811, 2.0 mils thick.

2.04 MISCELLANEOUS METAL SUB-FRAMING COMPONENTS

- A. Steel Sheet Components, General: Complying with ASTM C 645 requirements for metal and with ASTM A 653, G60, hot-dip galvanized or manufacturer's standard corrosion-resistant coating.
- B. Subgirts: C- or Z-shaped sections fabricated from 0.0598-inch steel thickness, non-corrosive, cold-formed, steel sheet.
- C. Zee Clips or Sill Angles: 0.079-inch steel thickness, cold-formed, galvanized steel sheet.

- D. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base Metal Thickness: 24 gauge.
 - 2. Depth: 7/8 inch or 1-1/2 inches, as indicated.
- E. Cold-Rolled Furring Channels: 0.0538-inch bare steel thickness, with minimum 1/2-inch wide flange.
 - 1. Depth: 3/4 inch.
 - 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare steel thickness of 0.0312 inch.
 - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch diameter wire, or double strand of 0.0475-inch diameter wire.
- F. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.
- G. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.05 ACCESSORIES

- A. Metal Panel Accessories: Provide components required for a complete metal panel assembly including trim, copings, fascia, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels.
 - 1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
 - 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
- B. Flashing and Trim: Formed from 0.0209 inch- thick, aluminum pre-anodized or prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fascia, parapet caps, soffits, reveals, and filler panels. Finish flashing and trim with same finish system as adjacent metal panels.
- C. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads.
 - 1. Fasteners for Panels: Self-drilling or self-tapping, zinc-plated, hex-head carbon-steel screws, with a stainless-steel cap or zinc-aluminum-alloy head and EPDM or neoprene sealing washer.
 - 2. Exposed Fasteners where allowed: Stainless steel.
- D. Gaskets: UV stabilized, non-cellular neoprene, EPDM, or Santoprene gaskets; ASTM C 864, 70 Shore A durometer. Corners shall be heat welded to form a weather-tight seal.
- E. Low-Friction Isolators: Wherever materials are subject to relative movement by design, provide suitable low-friction materials to allow such movement equal to Teflon, Nylatron or other high-density polystyrene strips or pads.
- F. Drainage Diverters: Where require to maintain drainage provide metal assemblies formed from 0.0209-inch- thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating; in 10-foot- long sections, complete with formed elbows and offsets. Finish diverters to match metal panels.

2.06 FABRICATION

- A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.
 - 1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.

2. Fabricate wall panels with panel stiffeners as required to maintain fabrication tolerances and to withstand design loads.
 3. Fabricate metal panels in a manner that eliminates condensation on interior side of panel and with joints between panels designed to form weathertight seals.
- B. Metal-Faced Composite Panels: Factory form panels in a continuous process by laminating each sheet using manufacturer's proprietary bonding system. Trim and square edges of sheets with no displacement of face sheets or protrusion of core material.
1. Dimensional Tolerances:
 - a. Length: Plus 0.375 inch.
 - b. Width: Plus 0.188 inch.
 - c. Thickness: Plus or minus 0.008 inch.
 - d. Panel Bow: 0.8 percent maximum of panel length or width.
 - e. Squareness: 0.2 inch maximum.
- C. Sheet Metal Accessories: Fabricate flashing and trim as indicated or where not indicated in accordance with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

2.07 SEALANT MATERIALS

- A. Weep Hole Filter: PVC-coated reticulated open-cell urethane foam, 40% minimum porosity.
- B. Panel Sealants:
1. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.

2.08 FINISHES ON ALUMINUM PANELS AND TRIM

- A. Application of coated finishes shall comply with AAMA 605.2 "Specification for High Performance Organic Coatings on Architectural Aluminum Extrusions and Panels".
- B. Surfaces shall match the appearance, color and sheen of samples submitted and approved, including jobsite mock-ups.
1. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces or other components and trim are acceptable if they are within one-half of the range of approved Samples, when viewed under a uniform light source such as north daylight.
 2. The surface quality of the finished coating shall be smooth and free of streaks and imperfections. The coating shall be opaque and uniform in color and tonality.
 3. All finishes exposed to view shall be finished. No mill finish aluminum shall be permitted as an exposed finish.
- C. Three-Coat PVDF Coating: Factory applied 3-coat, thermocured system consisting of specially formulated primer and fluoropolymer color topcoat containing not less than 70% polyvinylidene fluoride resin by weight. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605.
1. Primer: compatible with color coat, not less than 0.2 mils thick.
 2. Color Coating: 70% Kynar PVDF, not less than 0.7 mils thick.
 3. Clear Barrier Coating: medium gloss, not less than 0.4 mils thick.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of work.
 - 1. Examine primary and secondary wall framing to verify that sub-girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal panel manufacturer.
 - 2. Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal panel manufacturer.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal panel installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
- B. Substrate Board: Install substrate board over wall or soffit framing on entire wall surface. Attach with substrate-board fasteners.
 - 1. Install substrate board with long joints in continuous straight lines, perpendicular to direction of metal wall panel seams with end joints staggered between rows. Tightly butt substrate boards together.
- C. Miscellaneous Framing: Install subgirts, base angles, furring, and other miscellaneous panel sub-framing and anchorage according to ASTM C 754 and metal panel manufacturer's written recommendations.

3.03 UNDERLAYMENT INSTALLATION

- A. Install underlayment membrane over exterior face of exterior wall substrate in accordance with manufacturer recommendations.
- B. Start membrane installation at corners, leaving 6-12 inches of membrane to overlap.
 - 1. Install membrane in a horizontal manner starting at the lower portion of the wall surface with subsequent layers installed in a shingling manner to overlap lower layers.
 - 2. Seal seams of membrane with seam tape at all vertical and horizontal overlapping seams.
 - 3. Seal any tears or cuts as recommended by weather barrier manufacturer.
- C. Thru-Wall Flashings: Install adhesive type flashings as recommended by membrane manufacturer that are compatible with substrates encountered. Lap and seal flashings to provide a water-tight installation.

3.04 METAL PANEL INSTALLATION

- A. General: Install attachment system required to support metal panels in accordance with approved submittals, including subgirts, perimeter extrusions, drainage channels, panel clips, and anchor channels.
 - 1. Commence metal panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.
 - 2. Shim or otherwise plumb substrates receiving metal panels.

3. Flash and seal metal panels with weather closures at perimeter of all openings. Do not begin installation until weather barrier and flashings, concealed by panels, are installed.
 4. Install flashing and trim as metal panel work proceeds.
 5. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
 6. Provide weathertight trim, as approved on submittals, for pipe and conduit penetrating exterior walls.
- B. Attachment System, General: Install attachment system required to support metal plate wall panels and to provide a complete weathertight wall system, including subgirts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.
1. Attach panel sub-girt system through sheathing to metal subframing.
 2. Attach panel clips to supports at locations, spacings and with fasteners recommended by manufacturer. Attach flanges of wall panels to panel clips with fasteners as recommended by manufacturer.
- C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action as recommended by metal plate wall panel manufacturer.
- D. Joint Sealers: Install joint sealants where indicated and where required for weathertight performance of metal wall plate panel assemblies.
1. Seal metal wall panel end laps with double beads of sealant, full width of panel. Seal side joints where recommended by panel manufacturer.
 2. Seal horizontal and vertical joints between adjacent construction and metal wall panels with sealant backing and sealant. Install sealant backing and sealant according to requirements specified in Division 07 Section "Joint Sealants."

3.05 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Install components required for a complete metal panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

3.06 ERECTION TOLERANCES

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

3.07 CLEANING AND PROTECTION

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

END OF SECTION

SECTION 07 54 23

SINGLE-PLY MEMBRANE ROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Mechanically-fastened single-ply, Class A rated, membrane roofing system.
 - 2. Above-deck insulation board.
- B. Related Sections include the following:
 - 1. Section 06 10 50 for "Rough Carpentry" for wood nailers, curbs, and blocking.
 - 2. Section 07 21 16 for "Building Insulation" for insulation beneath the roof deck.
 - 3. Section 07 92 00 for "Joint Sealants."

1.02 PERFORMANCE REQUIREMENTS

- A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified wind-uplift pressures, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Provide roofing materials that are compatible with one another for application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.
- C. Roofing System Design: Provide a membrane roofing system that has been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE 7 and IBC 1609, Exposure C, Category II, Basic Wind Speed of 90 mph, with a safety factor of 1.2. The minimum uplift load capacity of the roof membrane and insulation or substrate board system shall be:
 - 1. Roof Area Field: -25.5 psf.
 - 2. Roof Area Perimeter: -38.2 psf, 16-ft width.

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's literature and technical specifications for each type of product.
- B. Shop Drawings: For roofing system. Include plans, details, and attachments to other Work.
 - 1. Flashings and membrane terminations.
 - 2. Cover board and membrane fastening patterns.
- C. Certificates:
 - 1. Evidence of UL, ICBO and FMG ratings, as applicable to the Project.
 - 2. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
 - 3. Manufacturer's Letter of Certification that their products meet and comply with the materials and intent of the Specification, and manufacturer's installation instructions.
 - 4. At Project close-out, provide manufacturer's representative(s) certifications that products approved are products installed on the Project.
- D. Inspection Reports: Roofing manufacturer's reports of inspections and completed roofing installation.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.
- B. Manufacturer Qualifications: A qualified manufacturer that has UL listing for membrane roofing system identical to that used for this Project.
- C. Source Limitations: Obtain components for membrane roofing system approved by roofing membrane manufacturer.
- D. Fire-Test-Response Characteristics: Provide membrane roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, or other testing agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
 - 1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application indicated.
- E. Pre-Installation Conference:
 - 1. Prior to commencement of roofing installation and associated work, schedule a meeting with General Contractor, roofing system manufacturer's representative, and affected trades to review procedures related to roofing work, including but not necessarily limited to the following:
 - a. Review structural loading limitations of roof deck construction, and inspect deck for loss of flatness and for required attachment.
 - b. Review roofing system requirements (drawings, specifications and other Contract Documents).
 - c. Review required inspections, testing and certifications required to provide warranty compliance.
 - d. Review Flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 - e. Review governing regulations and requirements for insurance and certificates if applicable.
 - f. Review temporary protection requirements for roofing system during and after installation.
 - 2. Contractor shall submit to Architect documentation of revised materials, installation details or other information, at variance from approved submittals.
 - 3. Contractor shall prepare minutes of the meeting and furnish copy of record to each party attending, to Architect and Owner.
 - 4. Provide schedule of roofing installation inspections performed by roof membrane manufacturer. Distribute subsequent written reports of observations to Architect and Owner.

1.05 STORAGE AND HANDLING

- A. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- B. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.06 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.07 WARRANTY

- A. Roofing Manufacturers Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.

1. Warranty includes all components of membrane roofing system such as roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, and walkway products that fail within the specified warranty period.
 2. Warranty Period: 15 years from date of installation completion.
- B. Roofing Installer's Warranty: Submit roofing Installer's warranty, signed by Installing Contractor, covering Work of this Section, including all components of roofing system for the following warranty period:
1. Warranty Period: Two years from date of Substantial Completion.

PART 2 = PRODUCTS

2.01 THERMOPLASTIC POLYOLEFIN ROOFING MEMBRANE

- A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, uniform, flexible sheet formed from a thermoplastic ethylene-propylene polyolefin, internally scrim fabric reinforced, and as follows:
1. Acceptable Manufacturers:
 - a. Firestone Building Products; Ultraply TPO.
 - b. Carlisle SynTec Inc; Sure-Weld TPO
 - c. GAF; EverGuard TPO.
 2. Thickness: 60 mils, nominal.
 3. Exposed Face Color: White.
 4. Physical Properties:
 - a. 3-year Aged Solar Reflectance Value: 0.70 minimum; ASTM C 1549.
 - b. Breaking Strength: 360 lbf; ASTM D 751, grab method.
 - c. Puncture Resistance: 350 lbf; FTM 101C Method 2013.
 - d. Elongation Break of Scrim Reinforcement: 15 percent minimum; ASTM D 751.
 - e. Tearing Strength: 130 lbf minimum; ASTM D 751, Procedure B.
 - f. Field Seam Strength: 60 lbf/in ASTM D 1876, peel method.
 - g. Resistance to Heat Aging: 90 percent minimum retention of breaking strength and tearing strength after 600 hours at 240 deg F; ASTM D 573.

2.02 AUXILIARY MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.
- B. Sheet Metal Flashing: ASTM A 653, 24 ga., G60 coating designation; structural quality, mill phosphatized to receive manufacturers proprietary TPO coating.
- C. Bonding Adhesive: Manufacturer's standard solvent based bonding adhesive for membrane, and solvent-based bonding adhesive for base flashings.
- D. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- E. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
- F. Miscellaneous Accessories: Provide preformed cone vent flashings, preformed inside and outside corner sheet flashings, T-joint covers, termination reglets, cover strips, and other accessories.

2.03 INSULATION BOARD

- A. General: Provide preformed roof insulation boards manufactured or approved by membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses required to achieve thermal insulation performance of R-30 above roof deck.
 - 1. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, non-organic, glass-fiber mat facer on both surfaces with an aged R-value of not less than R-5.6 per inch thickness.
 - a. Fire Hazard Rating: UL Class C over steel deck assemblies.
 - b. Minimum Compressive Strength: 20 psi.
 - c. Maximum Board Thickness: 2 1/2-inch.
 - d. Maximum Board Size: 48 inch by 96 inch.
- B. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes fabricated to maintain minimum drainage slope of 1/8 inch fall in 12 inches of run.

2.04 ACCESSORIES

- A. Provide preformed insulation board saddles, crickets, tapered edge strips, and other insulation shapes fabricated to maintain minimum drainage slope of 1/4 inch fall in 12 inches of run.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer. Provide specialty fasteners or increased spacing where OSB sheathing alternates are accepted by Owner.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine subsurfaces to receive Work and report detrimental conditions.
 - 1. Prior to the application of roofing materials, the Contractor shall examine the roof deck insulation board, crickets, flashings, and other surfaces receiving roofing materials to ensure that surfaces are clean, primed and in proper condition to receive the roofing system.
 - 2. All penetrations through roofing, including drains, scuppers, pipe, vent and electrical conduit penetrations shall be completed prior to the starting of membrane application.
 - 3. The Contractor shall report in writing to the Owner any condition unacceptable to the Contractor's proper installation of roofing materials prior to proceeding with the work.
 - a. Application of roofing materials shall constitute the roofing Contractor's acceptance of surfaces and flashings to receive roofing materials.

3.02 INSULATION BOARD INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system manufacturer's written instructions for installing insulation.
 - 1. Secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - a. Space fastener placement to resist design uplift pressure at corners, perimeter, and field of roof, in accordance with ASCE 7.
 - 2. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Cut and fit insulation within 1/4 inch of vertical surfaces, nailers, projections, and penetrations.
 - 3. Install one or more layers of insulation to achieve required thickness. Where overall insulation thickness is 2 inches or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches in each direction.
 - 4. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
 - 5. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

3.03 MECHANICALLY ATTACHED MEMBRANE INSTALLATION

- A. Install roofing membrane over areas to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane to relax before installing.
 - 1. Roof membrane shall be unrolled on the area to be covered so that side seams are perpendicular to metal deck flutes. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer.
 - 2. Mechanically fasten roofing membrane securely at edge terminations, penetrations, and perimeter of roofing, pulling membrane taut to eliminate wrinkles or bubbles.
 - 3. Clean seam surfaces, over lapping fastener plates, and weld seams using manufacturers approved hot-air welding equipment and methods to secure seams.
 - 4. Apply continuous cut-edge sealant bead along seam edges.

3.04 FLASHING INSTALLATION

- A. Install perimeter flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
 - 1. Apply bonding adhesive to substrate and underside of sheet flashing at a rate of approximately one gallon per 60 square feet of surface coverage and allow to partially dry.
 - 2. Terminate and seal top of perimeter flashings with manufacturer's standard pressure-bar. Provide pre-molded inside and outside corners terminations.
 - 3. Flash penetrations with manufacturer's standard pre-molded boots.
 - 4. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.
- B. Roof Drains: Set metal flashing in bed of roofing sealant over roofing membrane in accordance with manufacturer's details. Cover metal flashing with roofing membrane sheet stripping and extend a minimum of 6 inches beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof-drain clamping ring.
- C. Vertical Pipe Penetrations: At pipe projections extending above roof covering, turn roof membrane sheet up projection a minimum height of 4-inches. Cover termination with umbrella-type counter-flashing and secure with clamp-ring.
- D. Scuppers: Where thru-wall scuppers are indicated, install three-piece, 24 ga. sections in accordance with SMACNA Plate 26 details, unless otherwise indicated.

3.05 FIELD QUALITY CONTROL

- A. Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation as work progresses and on completion and submit reports to Architect.

3.06 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of installation period.
- B. Correct deficiencies in membrane roofing system that do not comply with requirements. Repair substrates or reinstall membrane roofing system to a condition free of damage and deterioration at time of completion and according to warranty requirements.
- C. Clean adhesives, overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

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SECTION 07 72 00

ROOF ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Roof hatches.
- B. Related Sections include the following:
 - 1. Section 05 50 00 "Metal Fabrications" for ladders and miscellaneous metal framing and supports.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, materials, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other Work.
- C. Coordination Drawings: Roof plans drawn to scale and coordinating penetrations and roof-mounted items. Show method of attaching roof accessories to roof membrane or building structure.
- D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for roof accessories with factory-applied color finishes.

1.03 QUALITY ASSURANCE

- A. Standards: Comply with the following:
 - 1. SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.
 - 2. NRCA's "Roofing and Waterproofing Manual" details for installing units.

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. Roof Hatches:
 - a. Babcock-Davis Hatchways, Inc.
 - b. Bilco Company.
 - c. Dur-Red Products, Inc.

2.02 MATERIALS, GENERAL

- A. Aluminum Sheet: ASTM B 209 for alclad alloy 3005H25 or alloy and temper required to suit forming operations, with mill finish, unless otherwise indicated.

- B. Galvanized Steel Sheet: ASTM A 653 with G90 coating designation; commercial quality, unless otherwise indicated.
- C. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M with Class AZ-50 coating, structural quality, Grade 40, or as required for strength.
- D. Insulation: Manufacturer's standard rigid or semirigid glass-fiber board of thickness indicated.
- E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, complying with AWPA C2; not less than 1-1/2 inches thick.
- F. Fasteners: Same metal as metals being fastened, or stainless steel or other noncorrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.
- H. Elastomeric Sealant: Generic type recommended by unit manufacturer that is compatible with joint surfaces; ASTM C 920, Type S, Grade NS, Class 25, and Uses NT, G, A, and, as applicable to joint substrates indicated, O.

2.03 ROOF HATCHES

- A. General: Fabricate units to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loading pressure. Frame with minimum 12-inch- high, integral-curb, double-wall construction with 1-1/2-inch insulation, formed cants and cap flashing (roofing counterflashing), with welded mechanical corner joints. Provide double-wall cover (lid) construction with 1- inch- thick insulation core. Provide gasketing and equip with corrosion-resistant hardware including pintle hinges, hold-open devices, interior padlock hasps, and both interior and exterior latch handles.
- B. Type: Single-leaf personnel access.
 - 1. For Ladder Access: Bilco Model: Type E (36 by 36 inches).
 - 2. Material: 14 ga. steel sheet curbs and cover.
 - 3. Finish: Galvanized.
- C. Fall Protection: 1 1/4" Schedule 40 aluminum pipe rail assembly with post clamp-supports mounted to corners of roof-hatch curb flange.
 - 1. Rail Height: 42-inches above roof surface.
 - 2. Gate Hardware: Stainless-steel, self-closing spring hinges and latch.
 - 3. Finish: Powder-coated "Safety-Yellow".
 - 4. Approved Manufacturer: Bilco Model: Bil-Guard 2.0
- D. Safety Post Extension: Telescoping steel pipe assembly, secured to ladder rungs.
 - 1. Rail Height: 30-inches above roof surface.
 - 2. Hardware: Stainless-steel, spring latch.
 - 3. Finish: Powder-coated "Safety-Yellow".
 - 4. Approved Manufacturer: Bilco Model: LU-1.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Comply with manufacturer's written instructions. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight. Anchor roof accessories

securely to supporting structural substrates so they are capable of withstanding lateral and thermal stresses, and inward and outward loading pressures.

- B. Install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual," unless otherwise indicated,
- C. Flange Seals: Unless otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal.

3.02 CLEANING AND PROTECTION

- A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings.

END OF SECTION

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SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes sealants for the following applications:
 - 1. Exterior joints in the following vertical surfaces and nontraffic horizontal surfaces:
 - a. Control and expansion joints in unit masonry.
 - b. Control joints in concrete tilt-panel construction.
 - c. Joints between steel framing and tilt-panels.
 - d. Joints between metal panels and trim.
 - e. Control and expansion joints in EIFS finish systems.
 - f. Perimeter joints of door and window frames.
 - g. Control and expansion joints in soffits and overhead surfaces.
 - h. Joints between different materials and other joints as indicated.
 - 2. Exterior joints in the following horizontal traffic surfaces:
 - a. Control and expansion joints in concrete pavements.
 - 3. Interior joints in the following vertical surfaces:
 - a. Wall joints in concrete tilt-panel construction.
 - b. Perimeter window framing.
 - c. Acoustical sealant applications in gypsum board wall assemblies.
- B. Related Sections include the following:
 - 1. Section 03 30 00 for "Cast-in-Place Concrete" for joint filler sealants in concrete floor slabs.
 - 2. Section 08 80 00 for "Glass and Glazing" for glazing sealants.

1.02 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.03 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated and manufacturer's color charts.
- B. Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in-service performance.

1.05 PROJECT CONDITIONS

- A. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

1.06 WARRANTY

- A. Warranty: Provide written warranty, signed by Installer and sealant manufacturers agreeing to repair or replace joint sealants at no additional cost to Owner because of loss of adhesion or cohesion, do not cure or fail to meet other performance requirements specified in this Section within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.
- B. Warranties specified in this Article exclude deterioration or failure of joint sealants caused from the following:
 - 1. Joint movement of the structure exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or movement attributable to design or construction.
 - 2. Mechanical damage caused by individuals, tools, or other outside agents.
 - 3. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL

- A. Single Source: Provide materials and sealants for each sealant type from a single manufacturer. Where sealants from different manufacturers are in contact with one another, provide written compatibility statements from each manufacturer.
- B. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
- C. Materials: Primers, backer materials, joint fillers, bond breakers, cleaners and related materials shall be compatible with and as recommended by each respective sealant manufacturer.
- D. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and capable of being removed without damage to adjacent surfaces.

2.02 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealant Standard: Comply with requirements indicated for each liquid-applied chemically curing sealant in the Elastomeric Joint-Sealant Schedule at the end of Part 3, including those referencing ASTM C 920 classifications for type, grade, class, and uses.
- B. Colors of Exposed (unpainted) Joint Sealants:
 - 1. Traffic Joints: As selected from manufacturer's full range of standard colors.
 - 2. Perimeter Window Framing Joints: As selected from manufacturer's full range of standard colors.
 - 3. Masonry, EIFS and Tilt-Panel Joints: Custom color tinted to match adjacent wall material colors.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Window System Perimeter Joint Width: Verify with window system installer that rough openings and fabrication of framing systems will ensure perimeter sealant joint widths do not exceed 3/4 inch or are less than 3/8 inch in width.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include; concrete, masonry and unglazed surfaces of tile.
 - 3. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Non-porous joint surfaces include; metal, glass, porcelain enamel and glazed surfaces of tile.
- B. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply. Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- B. Acoustical Sealant Application Standard: Comply with recommendations of ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials and conditions indicated.
- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.
- E. Install sealants to comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses provided for each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Remove excess sealants from surfaces adjacent to joint.
- F. Tooling of Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants to form smooth, uniform beads of concave configuration; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

- G. Traffic Joints: Dust traffic joints with mica sand before sealant has formed a skin.

3.04 FIELD QUALITY CONTROL

- A. Field Water-Penetration Testing: At Owner's option and cost, random testing of joints may be done, using a continuous hose-stream technique. If uncontrolled water is observed on the interior, after initial hose-stream test, additional testing and remedial measures will be required.

3.05 CLEANING

- A. Clean excess sealants or sealant smears adjacent to joints by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.06 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion.

3.07 ELASTOMERIC JOINT-SEALANT SCHEDULE

- A. Type "A": Single-component, non-tracking, self-leveling, polyurethane/silicone sealant meeting FS TT-S-00230C Type I, Class A and and/or ASTM C 920 Type S, Class 25 with a Shore A of 25 or better upon curing.
 - 1. Type and Grade: M (multi-component) and P (pourable).
 - 2. Class: 35
 - 3. Joint Movement: plus or minus 25% of joint width.
 - 4. Use Related to Exposure: T (traffic)
 - 5. Applications: Driveways, walks and truckcourt pavements (tooled or saw-cut) joints.
 - 6. Approved Manufacturers:
 - a. BASF; MasterSeal SL100 (35%)
 - b. Sikaflex; 1c SL (25%)
 - c. Tremco; Vulkem 445 SSL (35%)
 - d. 3M; 530SL (25%)
- B. Type "B": Medium-modulus, neutral-cure silicone rubber sealant meeting FS TT-S-00230C, Class A, and/or ASTM C 920 with a Shore A of 25 upon curing.
 - 1. Type and Grade: S (single component) and NS (nonsag).
 - 2. Class: 50
 - 3. Joint Movement: plus or minus 50% of joint width.
 - 4. Use Related to Exposure: NT (non-traffic)
 - 5. Applications: Metal to metal, perimeter window/door frames, and metal to concrete joints.
 - 6. Approved Manufacturers:
 - a. DOW 756 SMS
 - b. Sikasil; WS-295 (50%)
 - c. Tremco; Spectrum 2 (50%)
- C. Type "C": Single-component, non-staining, (paintable) hybrid-polymer sealant meeting FS TT-S-001543A, Type II, Class A and/or ASTM C 920 with a Shore A of 15 upon curing.
 - 1. Type and Grade: S (single component) and NS (nonsag).
 - 2. Class: 50
 - 3. Joint Movement: plus or minus 50% of joint width.
 - 4. Use Related to Exposure: NT (non-traffic)
 - 5. Applications: Vertical concrete tilt-panel and EIFS control joints.
 - 6. Approved Manufacturers:
 - a. BASF; MasterSeal NP-150 (50%)

- b. SikaHyflex; 150 LM (50%)
 - c. Tremco; Dymeric 240 (50%)
- D. Type "D": One-part, non-staining, siliconized acrylic latex sealant meeting ASTM C 834 with a Shore A of 15 upon curing.
 - 1. Type and Grade: S (single component) and NS (nonsag).
 - 2. Use Related to Exposure: INT (interior, non-traffic)
 - 3. Applications: Interior window/door frame to wall joints.
 - 4. Approved Manufacturers:
 - a. BASF Sonolac
 - b. Tremco; Tremflex 834
 - c. Pecora; AC-20
- E. Type "E": One-part, acrylic latex sealant meeting ASTM C 834.
 - 1. Type and Grade: S (single component) and NS (nonsag).
 - 2. Applications: Gypsum board acoustical wall assemblies.
 - 3. Approved Manufacturers:
 - a. Pecora; AIS-919
 - b. Tremco; Acoustical Sealant
 - c. US Gypsum; SHEETROCK Sealant.

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SECTION 08 11 00

HOLLOW-METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Hollow-metal insulated steel doors.
 - 2. Hollow-metal steel door frames.
- B. Related Sections include the following:
 - 1. Section 08 71 00 for "Door Hardware" for door hardware and weather stripping.
 - 2. Section 09 91 13 for "Painting" for field painting factory-primed doors and frames.

1.02 SUBMITTALS

- A. Product Data: For each type of door and frame indicated, include door designation, type, level and model, material description, core description, construction details, label compliance, sound and fire-resistance ratings, and finishes.
- B. Shop Drawings: Show the following:
 - 1. Elevations and frame details for each frame type including dimensioned profiles.
 - 2. Details of anchorages, accessories, joints, and connections.

1.03 QUALITY ASSURANCE

- A. Steel Door and Frame Standard: Comply with ANSI/SDI A 250.8, unless more stringent requirements are indicated.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames. Remove and replace damaged items that cannot be repaired as directed.

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. Steel Doors and Frames:
 - a. Imperial/Legion/Regent Composite Doors; Ceco Door Products.
 - b. L-18 Series; Steelcraft; Allegion Brands.
 - c. C/CM Series; Curries AADG, Inc.

2.02 MATERIALS

- A. Steel Sheets: ASTM A 924 - Specification for General Requirements for Steel Sheet, Metallic-coated by the Hot-Dip Process.
- B. Cold-Rolled Steel Sheets: ASTM A 366, Commercial Steel (CS), or ASTM A 620, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness.
- C. Electrolytic Zinc-Iron Coated Steel Sheet: ASTM A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process. Commercial Steel (CS), A40 or A60 coating; mill phosphatized; suitable for exposed applications; stretcher-leveled standard of flatness for face sheets.

2.03 DOORS

- A. Doors: Provide doors of sizes indicated, 1 3/4" thickness, complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
 - 1. Exterior Doors: 18 gauge, ASTM A 653, A-60 galvannealed steel, Level 2, Performance Level B (Heavy Duty), Model 2, seamless epoxy-filled edges.
 - 2. Interior Doors: 20 gauge, ASTM A 653, A-40 galvannealed steel, Level 1, Performance Level C (Standard Duty), Model 1, full-flush edges.
- B. Vision Lite: Manufacturer's standard kits consisting of glass lite moldings to accommodate glass thickness and size of vision lite indicated.
- C. Door Louvers: Provide louvers for exterior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.020-inch- thick, cold-rolled steel sheet set into 0.032-inch- thick steel frame.

2.04 FRAMES

- A. Door Frames: Provide steel frames for doors, transoms, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated.
 - 1. Exterior Frames: 16 gauge, A-60 galvanized steel, continuously welded seamless corners.
 - 2. Interior Frames (Drywall Openings): 16 gauge, A-40 galvanized steel, three-piece knock-down drywall slip-on frame profile with interlocking tabs at frame corners.
 - 3. Fire Rating Labels: Provide frame units bearing Labels for ratings as scheduled on Drawings.
- B. Door Silencers: Except on weather-stripped frames, fabricate stops to receive three silencers on strike jambs of single-door frames and two silencers on heads of double-door frames.
- C. Supports and Anchors: Fabricated from not less than 0.056-inch- thick, electrolytic zinc-coated or metallic-coated steel sheet.
- D. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A 153, Class C or D as applicable.

2.05 FABRICATION

- A. General: Fabricate steel door and frame units to comply with ANSI A250.8 and to be rigid, neat in appearance, and free from defects including warp and buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site.
- B. Exterior Door Construction: For exterior locations and elsewhere as indicated, fabricate doors, panels, and frames from galvanized steel sheet. Close top and bottom edges of doors flush as an integral part of door construction or by addition of heavy-gauge, metallic-coated steel channels with channel webs placed even with top and bottom edges.

- C. Door Core Construction: Manufacturer's standard core construction that produces a door complying with SDI standards, and as follows:
 - 1. Polyurethane Core: Full 1 3/4-inch thick expanded polyurethane foam core bonded to inside faces of door panels. Minimum R-Value: 2.8 per inch thickness.
- D. Clearances for Non-Fire-Rated Doors: Not more than 1/8 inch at jambs and heads, except not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.
- E. Clearances for Fire-Rated Doors: As required by NFPA 80.
- F. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- G. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.
- H. Thermal-Rating: At exterior locations and elsewhere as shown or scheduled, provide doors fabricated as thermal-insulating door assemblies and tested according to ASTM C 236 or ASTM C 976 on fully operable door assemblies.
- I. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements in ANSI A250.6 and ANSI A115 Series specifications for door and frame preparation for hardware.
- J. Frame Construction: Fabricate frames to profiles shown. Fabricate frames with mitered and continuously welded seamless corners and face joints.
- K. Reinforce doors and frames to receive surface-applied hardware. Locate hardware as indicated on Shop Drawings. Drilling and tapping for surface-applied hardware may be done at Project site.
- L. Glazing Stops: Manufacturer's standard profile formed as an integral part of the glazing frame on the exterior side of door or sidelight with screw-applied, removable, glazing stops on interior side of glass.

2.06 FINISHES

- A. Prime Finish: Manufacturer's standard, factory-applied coat of rust-inhibiting primer complying with ANSI A250.10 for acceptance criteria.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Install steel doors, frames, and accessories according to Shop Drawings, manufacturer's data, and as specified.
- B. Placing Frames: Comply with provisions in SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
 - 1. In cast-concrete construction, provide at least three completed opening anchors per jamb; install adjacent to hinge location on hinge jamb and at corresponding heights on strike jamb. Set frames and secure to adjacent construction with bolts and masonry anchorage devices. For openings 90 inches or more in height, install an additional anchor at hinge and strike jambs.
 - 2. For in-place gypsum board partitions, install knock-down, drywall slip-on frames.
 - 3. Install fire-rated frames according to NFPA 80.

- C. Door Installation: Comply with ANSI A250.8. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI A250.8. Shim as necessary to comply with SDI 122 and ANSI/DHI A115.1G.

3.02 ADJUSTING AND CLEANING

- A. Prime-Coat Touchup: Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch up of compatible air-drying primer.

END OF SECTION

SECTION 08 12 23

INTERIOR ALUMINUM DOOR FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes: Pre-finished interior aluminum frames for doors and glazing applications.

1.02 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of interior aluminum frame indicated.
- B. Maintenance Data: For interior aluminum frames to include in maintenance manuals.
- C. Shop Drawings: Show the following:
 - 1. Elevations of each door and window type.
 - 2. Frame details for each frame type including dimensioned profiles.
 - 3. Details of anchorages, accessories, joints, and connections.
 - 4. Coordination of glazing frames and stops with glass and glazing requirements.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with the following:
 - a. 2010 ADA "Standards for Accessible Design" and ADA Guidelines, as applicable.
 - b. 2021 International Building Code, Chapter 11.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: The design of aluminum framing system products are based on the following:
 - 1. Series 300; Western Integrated Materials, Inc.
 - a. Frame Face Profile: 1 1/2-inch.
 - b. Snap-on Trim Profile: 1-inch wide with 3/8-inch deep return.
- B. Available 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. Classic Series; RACO Interior Products, Inc.
 - 2. E-Frame Series; American Building Supply Architectural Components.

2.02 FRAMES

- A. Aluminum Framing, General: ASTM B 221, Alloy 6063-T5 or alloy and temper required to suit structural and finish requirements, not less than 0.062 inch thick.
- B. Window and Side-lite Frames: Extruded aluminum profile with pocket-type profile for 1/4" thick glass.
 - 1. Glazing Gasket: Extruded vinyl gasket.

- C. Door Frames: Pre-machined for hardware and reinforced for 4 1/2" x 4 1/2" square hinges.
 - 1. Door Silencers: Extruded vinyl gasket.
 - 2. Fabricate frame members with cold-formed steel liner where fire-rated frames are required.
- D. Trim: Extruded aluminum, not less than 0.062 inch thick, with removable snap-in casing trim without exposed fasteners.

2.03 ACCESSORIES

- A. Fasteners: Aluminum, nonmagnetic stainless-steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.
- B. Sound Seals: Manufacturer's standard continuous mohair, wool pile, or vinyl seals.
- C. Hardware: Comply with requirements in Section for "Door Hardware."

2.04 FABRICATION

- A. Machine jambs and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required, and fastened within frame with concealed screws.
- B. Provide concealed corner reinforcements and alignment clips for accurately fitted hairline joints at butted or mitered connections.
- C. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
- D. Fabricate all components to allow secure installation without exposed fasteners.

2.05 FLOAT GLASS

- A. Float Glass: ASTM C 1036, Type I (transparent glass, flat), Quality q3; 1/4 thick minimum and as follows:
 - 1. Safety Glazing: Comply with testing requirements in 16 CFR 1201.

2.06 ALUMINUM FINISHES

- A. Clear Anodic Finish: AA-M12C22A21 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, coating 0.010 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine walls and ceilings, with Installer present, for conditions affecting performance of work.
 - 1. Verify that wall thickness does not exceed standard tolerances allowed by throat size indicated.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with frame manufacturer's written installation instructions.

- B. Install frames plumb and square, securely anchored to substrates. Install alignment clips at corners to maintain tight-fitting, hairline joints.
- C. Install frame components in the longest possible lengths; components up to 98 inches long must be single piece.
 - 1. Use concealed frame clips to produce tightly fitted and aligned splices and connections.
 - 2. Secure clips to main structural extrusion components and not to snap-in or trim members.
 - 3. Do not leave screws or other fasteners exposed to view when installation is complete.

3.03 CLEANING

- A. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended by frame manufacturer and according to AAMA 609 & 610.
- B. Touch up marred frame surfaces so touchup is not visible from a distance of 48 inches. Remove and replace frames with damaged finish that cannot be satisfactorily repaired.

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SECTION 08 36 00

OVERHEAD SECTIONAL DOORS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following types of sectional overhead doors:
 - 1. Manual-lift insulated steel panel doors.
 - 2. Tracks configured for the following lift types:
 - a. Standard, vertical high-lift.
- B. Related Sections include the following:
 - 1. Section 09 91 13 for "Painting" for field-applied paint finish, if any.

1.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide sectional overhead doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:
 - 1. Wind Load: Uniform pressure (velocity pressure) of 15 lbf/sq. ft., acting inward and outward.
- B. Operation-Cycle Requirements: Design sectional overhead door components and operator to operate for not less than 10,000 cycles.

1.03 REFERENCES

- A. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI).
 - 1. ASCE/SEI 7: Minimum Design Loads for Buildings and Other Structures.
- B. Door & Access Systems Manufacturers Association International (DASMA).
 - 1. DASMA 102: Specification for Sectional Doors (ANSI).
 - 2. DASMA 105: Test Method for Thermal Transmittance and Air Infiltration of Garage Doors (ANSI).
 - 3. DASMA 163: R-value and U-factor as Applied to Residential or Commercial Garage Doors.

1.04 SUBMITTALS

- A. Product Data: For each type and size of sectional overhead door and accessory. Include details of construction relative to materials, dimensions of individual components, profiles, and finishes. Provide roughing-in diagrams, operating instructions, and maintenance information. Include the following:
 - 1. Setting drawings, templates, and installation instructions for built-in or embedded anchor devices.
 - 2. Motors: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.
 - 3. Wiring Diagrams: Detail wiring for power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring and between components provided by door manufacturer and those provided by others.
- B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied finishes.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who is an authorized representative of the sectional overhead door manufacturer for both installation and maintenance of units required for this Project.

1.06 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Deterioration of metals, metal finishes, gaskets and other materials beyond normal weathering.
 - c. Water leakage through fixed glazing.
 - d. Cohesive or adhesive insulation bond failure to panel faces.
 - e. Failure of operating components to function properly.
 - 2. Warranty Period:
 - a. Motors: Five (5) years from date of Substantial Completion.
 - b. Insulated Doors: One (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 INSULATED STEEL DOOR SECTIONS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:
 - 1. 426 Series; Overhead Door Corporation.
 - 2. 524S Series; Clopay Building Products Co.
 - 3. Amarr 2422 Series; Entrematic Group.
 - 4. S-24 Series; Raynor Door.
 - 5. Insul-Rite 5225; Rite-Hite Doors.
- B. Construct door panel sections from galvanized, structural-quality carbon-steel sheets complying with ASTM A 653, commercial quality, with a minimum yield strength of 33,000 psi and a minimum G60 zinc coating.
 - 1. Panel Section Thickness: 2-inch.
 - 2. Exterior Section Face Profile: 24-gauge, embossed texture, ribbed horizontal pattern.
 - 3. Interior Section Face Profile: 26-gauge, embossed texture, flat.
 - 4. Panel Insulation: Expanded Polystyrene; Minimum R-value: R-6.5.
 - 5. Demising Wall Door Opening Size: 12'-0" wide x 14'-0" high.
 - a. Door Operation: Motorized.
 - b. Color: Factory White.
 - 6. Ramp Door Opening Size: 18'-0" wide x 20'-0" high.
 - a. Door Operation: Motorized.
 - b. Color: Factory Tan.
 - 7. Ramp Door Opening Size: 12'-0" wide x 14'-0" high.
 - a. Door Operation: Motorized.
 - b. Color: Factory Tan.
 - 8. Dock Door Opening Size: 8'-0" wide x 10'-0" high.
 - a. Door Operation: Manual. 1/2" rope-pull hoist.
 - b. Color: Factory Tan.
- C. Fabricate door panel faces from a single sheet to provide sections not more than 24 inches high. Roll horizontal meeting edges to a continuous, interlocking, tongue-in-groove weathertight seal, with a reinforcing flange return.
- D. Enclose panel end sections with not less than 18-gauge galvanized steel channel end stiles.

1. Reinforce bottom section with a continuous channel or angle complying with bottom section profile and allowing installation of rubber astragal.
 2. Provide reinforcement and pre-punched holes for hardware attachment.
- E. Insulation: Insulate inner core of steel sections with foamed-in-place polyurethane or expanded polystyrene thermal insulation, with maximum flame-spread and smoke-developed indices of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely, with no exposed insulation material visible.
- F. Finish galvanized steel door sections with manufacturer's standard primer and baked polyester finish coats to interior and exterior door faces after forming, according to coating manufacturer's instructions for application, thermosetting, and minimum dry film thickness.
1. Color: Selected from manufacturers standard line.

2.02 TRACKS, SUPPORTS, AND ACCESSORIES

- A. Tracks: Provide manufacturer's standard, 12-gauge, G60 galvanized steel track system, designed for vertical high-lift type design, and clearances shown. Provide complete track assembly including brackets, bracing, and reinforcement for rigid support of ball-bearing roller guides for required door type and size. Slope tracks at proper angle from vertical or otherwise design to ensure tight closure at jambs when door unit is closed. Bolt track to wall supports.
- B. Track Reinforcement and Supports: Provide galvanized steel track reinforcement and support members. Secure, reinforce, and support tracks as required for door size and weight to provide strength and rigidity without sag, sway, and vibration during opening and closing of doors.
- C. Support and attach tracks to opening jambs with continuous angle welded to tracks and attached to wall.
- D. Weatherseals: Provide replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and at top of overhead door.
- E. View Window: Provide 6-inch by 18-inch single-pane glass window with rubber gasket seals. Locate in center of door.

2.03 HARDWARE

- A. General: Provide heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.
- B. Hinges: Provide heavy-duty galvanized steel hinges, of not less than 14-gauge uncoated steel, at each end stile and at each intermediate stile, per manufacturer's written recommendations for door size. Attach hinges to door sections through stiles and rails with bolts and lock nuts or lock washers and nuts. Use rivets or self-tapping fasteners where access to nuts is not possible. Provide double-end hinges, where required, for doors exceeding 16 feet in width, unless otherwise recommended by door manufacturer.
- C. Rollers: Provide heavy-duty rollers, with steel ball bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 2-inch- diameter roller tires and 2-inch track.
- D. Handles: 13-gauge galvanized steel step-plate/lifting handle on each side of bottom door panel.
- E. Slide Bolt: For manual-lift doors fabricate with side locking bolts to engage through slots in tracks for locking by padlock, located on single-jamb side, operable from inside only.
- F. Fabricate locking device assembly with lock, spring-loaded dead bolt, operating handle, cam plate, and adjustable locking bar to engage through slots in tracks.
1. Locking Bars: Single-jamb right-side, operable from inside only.

2. Provide safety interlock switch to disengage power supply when door is locked.

2.04 COUNTERBALANCING MECHANISM

- A. Torsion Spring: Operation by torsion-spring counterbalance mechanism consisting of adjustable-tension torsion springs, fabricated from oil-tempered-steel wire mounted on a cross-header tube or steel shaft. Connect to door with galvanized aircraft-type lift cables with cable safety factor of at least 5 to 1. Provide springs calibrated for 10,000 cycles minimum.
- B. Cable Drums: Provide cast-aluminum or gray-iron casting cable drums grooved to receive cable. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of shaft. Provide 1 additional midpoint bracket for shafts up to 16 feet long and 2 additional brackets at one-third points to support shafts more than 16 feet long.
- C. Cable Safety Device: Include a spring-loaded, steel or bronze cam mounted to bottom door roller assembly on each side, designed to automatically stop door if either cable breaks.
- D. Bracket: Provide anchor support bracket, as required to connect stationary end of spring to the wall, to level shaft and prevent sag.
- E. Provide a spring bumper at each horizontal track to cushion door at end of opening operation.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine wall and overhead areas, including opening framing and support framing, with Installer present, for compliance with requirements for installation tolerances, clearances, and other conditions affecting performance of Work of this Section.

3.02 INSTALLATION

- A. General: Install door, track, and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports according to Shop Drawings, manufacturer's written instructions, and as specified.
- B. Fasten vertical track assembly to wall supports at not less than 24 inches o.c.

3.03 ADJUSTING

- A. Adjust doors as follows:
 1. Test and adjust controls. Replace damaged and malfunctioning controls and equipment.
 2. Align and adjust pulleys, cables and springs for smooth operation.

END OF SECTION

SECTION 08 41 23

ALUMINUM-FRAMED ENTRANCES AND WINDOW WALLS

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Exterior aluminum-framed floor-to-floor window walls.
 - 2. Aluminum break-metal closure trim integral to window wall framing.
 - 3. Aluminum-framed entrance doors and hardware.
- B. Related Sections include the following:
 - 1. Section 07 92 00 "Joint Sealants" for installation of joint sealants installed with aluminum-framed window wall systems and for sealants to the extent not specified in this Section.
 - 2. Section 08 81 00 "Glass and Glazing" for glazing of glass within aluminum-framed window walls.

1.02 SYSTEM DESCRIPTION

- A. Design Requirements: Provide aluminum-framed systems of the appearance and profile intended, except as modified by performance requirements, as follows:
 - 1. Window wall framing system shall provide for, flush-retained, captured, glazing on all perimeter sides and intermediate framing. Glass shall be off-set towards front of frame.
 - 2. System shall be either screw-spline, shear-block, compensating-stick or unitized-frame system.
 - 3. Framing members design profile indicated on Drawings is: 2 1/2" wide x 7" deep and 2" wide x 4 1/2" deep.
 - 4. Finish: Class II, clear anodized.
- B. Performance Requirements: Provide aluminum-framed systems, including anchorage, capable of meeting, without failure, the effects of the following:
 - 1. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/min/sq. ft. of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 psf.
 - 2. Water Penetration Under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 8 psf. Leakage is defined according to AAMA 501.1, as no uncontrolled water penetrating framing systems normally exposed interior surfaces.
 - 3. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperature differential of 180 degrees F.
 - 4. Design Wind Pressure: Required by Code for building height location, but not less than 20 psf.
 - 5. Structural Performance: Provide window wall systems when tested according to ASTM E 330 at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 1/175 of span.

1.03 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of product indicated. Include project specific warranty form.
- B. Samples for Finish Verification: For each type of exposed finish required.

- C. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. For entrances, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer.
- B. Entrances: Comply with NAAMM "Entrance Manual" for requirements for aluminum doors.
- C. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201 and ANSI Z97.1.
- D. Accessible Entrances: Comply with 2010 – "ADA Standards for Accessible Design".
- E. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating framing systems without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.05 WARRANTY

- A. Special Assembly Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that deteriorate as defined in this Section within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Deterioration of metals, metal finishes, gaskets and other materials beyond normal weathering.
 - c. Water leakage through fixed glazing and framing areas.
 - d. Failure of operating components to function properly.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: The design of aluminum-framed storefront systems are based on AFG451 and AFG7251 as manufactured by Arcadia Architectural Products, Inc. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:
 - 1. Trifab VG 451T/1600 Wall; Kawneer Arconic Co.
 - 2. FT451/3250; US Aluminum.
 - 3. Reliance Series; Oldcastle Building Envelope.

2.02 MATERIALS

- A. Aluminum Framing: Alloy and temper recommended by manufacturer for type of use and finish indicated:
 - 1. Extrusions: 6063 T6 aluminum alloy, ASTM B 221.
 - 2. Sheet: ASTM B 209, 0.032 thick, aluminum.
 - 3. Plate: ASTM B 209, 0.125 thick, aluminum.

2.03 FRAMING SYSTEMS

- A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
- B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, fasteners and accessories compatible with adjacent materials complying with ASTM B 633.
- D. Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials. Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness to maintain a flat appearance without visible deflection.

2.04 GLAZING SYSTEMS

- A. Glazing Gaskets: Silicone compatible, compressible gaskets of molded santoprene complying with ASTM D 2000, or EPDM complying with ASTM C 864.
- B. Spacers and Setting Blocks: Manufacturer's standard elastomeric types.
- C. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25; neutral-curing silicone formulation compatible with glazing sealants and other system components. Sealant color: Black.

2.05 ALUMINUM-FRAMED DOORS

- A. Doors: Manufacturer's standard glazed doors, for manual swing operation.
 - 1. Door Construction: 1 1/2-inch overall thickness, with minimum 0.188-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and fillet welded or that incorporate concealed tie rods.
 - 2. Door Design: Medium stile; 3-1/2-inch nominal width stiles.
 - a. Bottom Rail: Smooth surfaced for width of door in area within 10 inches above floor or ground plane.
 - 3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets.

2.06 ENTRANCE DOOR HARDWARE

- A. General: Provide heavy-duty performance rated hardware as recommended by entrance system and hardware manufacturers for entrances and uses indicated.
 - 1. Continuous Hinges: BHMA A156.26, Grade 1, continuous geared, clear anodized aluminum full-mortise hinge for 2-inch frames. Pemko CFM 108HD1 or equal.
 - 2. Locking Hardware: BHMA E8211, Grade 1. Adams-Rite MS1950 or equal.
 - 3. Cylinders and Trim: BHMA A156.5, Grade 1.
 - 4. Operating Trim: BHMA A156.6.
 - 5. Off-set Push/Pulls: BHMA A156.6, 1 1/4-inch dia., stainless steel finish, 18" CTC mounting, solid-rod off-set pull. Rockwood RM 202 or equal.
 - 6. Overhead Surface Closers: BHMA A156.4, Grade 1, hydraulic type with integral stop/hold-open and narrow-profile aluminum cover, mounted on interior side of framing.
 - 7. Door Stops: BHMA A156.16, Grade 1, floor or wall mounted, as appropriate for door location indicated, with integral rubber bumper.
 - 8. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
 - 9. Aluminum Thresholds: Raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch. Mill finish.
 - 10. Silencers: BHMA A156.16, Grade 1.

2.07 ACCESSORY MATERIALS

- A. Joint Sealants: At perimeter of windowwall systems, as specified in Section 07 92 00 - "Joint Sealants."

2.08 FABRICATION

- A. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles are sharp, straight, and free of defects or deformations with accurately fitted joints with ends coped or mitered.
 - 2. Means to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
 - 3. Provisions for field replacement of glazing from exterior.
 - 4. Fasteners and connection devices that are concealed from view to greatest extent possible.
- B. Doors and Frames: Reinforce as required to support loads imposed by door operation and for installing hardware.

2.09 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Class II, Clear Anodic Finish: AA-M12C22 A31 complying with AAMA 611.
 - 1. Finish: mechanical, nonspecular as fabricated; chemical: etched, medium matte.
 - 2. Anodic Coating: Class II, clear coating not less than 0.4 mils thick.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and rough-opening dimensions and other conditions affecting performance of work. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions and approved shop drawings.
 - 2. Securely anchor components in accordance with approved structural calculations.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Install anchors with separators and isolators to prevent metal corrosion.
 - 5. Seal joints watertight and to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- B. Entrances: Install to produce smooth operation and tight fit at contact points.
 - 1. Field-Installed Hardware: Install surface-mounted hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
- C. Closure Trim: Install break-metal trim around steel columns, misc. steel framing and at corners to provide waterproof termination of framing systems and uniform appearance of installation.
- D. Sealants: Install perimeter joint sealants as specified in Section 07 92 00 "Joint Sealants" and to produce weathertight installation while maintaining internal drainage of framing system to exterior.
 - 1. Joint Width: 1/2 inch, plus or minus 1/8 inch.

- E. Erection Tolerances: Install aluminum-framed systems to comply with the following tolerances:
 - 1. Location and Plane: Limit variation to 1/8 inch in 12 feet, 1/4 inch over total length.
 - 2. Alignment: Where surfaces abut in line, limit offset from true alignment to 1/16 inch.
 - 3. Diagonal Measurements: Limit difference between diagonal measurement to 1/8 inch.
 - 4. Perimeter Sealant Joint Width: Verify that rough openings and fabrication of framing systems will ensure perimeter sealant joint widths do not exceed 3/4 inch or are less than 3/8 inch in width.

3.03 GLAZING

- A. Refer to Section 08 81 00 for installation of glass and glazing components.

3.04 FIELD QUALITY CONTROL

- A. Field Water Spray Test: Before installation of interior finishes has begun, a minimum area of 120 sq. feet of aluminum-framed systems at locations designated by Architect shall be field tested according to AAMA 501.2 and shall not evidence water penetration.
- B. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.05 ADJUSTING

- A. Door Entrances: Adjust operating hardware for smooth operation according to hardware manufacturers' written instructions.

3.06 PROTECTION AND CLEANING

- A. Protect framing from damage immediately after installation. Do not apply markers to aluminum surfaces. Remove nonpermanent labels, and clean surfaces.

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SECTION 08 42 29

SLIDING AUTOMATIC ENTRANCES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes automatic entrance door systems operating as follows:
 - 1. Exterior bi-parting, sliding automatic entrance doors with glass sliding and fixed panels.
- B. Related Sections include the following:
 - 1. Section 08 41 13 for "Aluminum Entrances and Storefronts" for entrances controlled by power door operators furnished separately from doors and frames.
 - 2. Section 08 71 00 for "Door Hardware" for lock cylinders.

1.02 DEFINITIONS

- A. Activation Device: Device that sends an electrical signal to the door operator to open the door.
- B. Safety Device: Device that prevents a door from opening or closing.

1.03 PERFORMANCEREQUIREMENTS

- A. Provide door assemblies capable of withstanding structural loads and movements based on manufacturer's standard units tested in assemblies similar to those indicated for this Project.
- B. Opening-Force Requirements for Egress Doors: Not more than 50 lbf required to manually open door if power fails, and not more than 15 lbf required to open door to minimum required width.
- C. Closing-Force Requirements: Not more than 30 lbf required to prevent door from closing.

1.04 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic entrance doors.
- B. Shop Drawings: Include plans, elevations, sections, details, hardware mounting heights, and attachments to other Work.
 - 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.
- C. Hardware Schedule: Include name of item and manufacturer, and complete designation of every item required for each automatic entrance door.
- D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.
- E. Maintenance Data: For door operators and control systems to include in maintenance manuals. Include instructions on how to perform safety tests, and the name, address, and telephone number of nearest authorized service representative.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of the automatic entrance door manufacturer for both installation and maintenance of units required for this Project.
 - 1. Certified Inspector: Installer shall employ an inspector certified by the American Association of Automatic Door Manufacturers.
 - 2. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Verify automatic entrance door openings by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating automatic entrance doors without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.07 COORDINATION

- A. Coordinate size and location of recesses in concrete floors for entrance door components.

1.08 WARRANTY

- A. General Warranty: Automatic Entrance Doors shall be free of defects in material and workmanship for a period of two (2) years from the date of substantial completion. Failures include, but are not limited to, the following:
 - 1. Faulty operation of operators and hardware.
 - 2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- B. During the warranty period the Owner shall engage a factory-trained technician to perform service and affect repairs. A safety inspection shall be performed after each adjustment or repair and a completed inspection form shall be submitted to the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis-of-Design Product: The design for automatic sliding entrance systems is based on Dura-Glide 2000 as manufactured by Stanley Access Technologies. Subject to compliance with requirements, provide the named product or the comparable product by one of the following:
 - 1. Profiler 2000B; Horton Automatics.
 - 2. SL500; Assa Abloy Entrance Systems.
 - 3. TX9200; Tormax USA.

2.02 MATERIALS

- A. Aluminum: Alloy and temper recommended by manufacturer for use and finish indicated.
 - 1. Headers, stiles, rails, and frames: 6063-T6
 - 2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - 3. Sheet and Plate: ASTM B 209.
- B. Sealants and Joint Fillers: Performed under Section 07 92 00 "Joint Sealants".

2.03 AUTOMATIC ENTRANCE DOOR ASSEMBLIES

- A. Provide manufacturer's standard automatic entrance door assemblies including doors, sidelites, framing, headers, carrier assemblies, roller tracks, door operators, activation and safety devices, and accessories required for a complete installation. Comply with the following:
- B. Sliding Automatic Entrance Doors:
 - 1. Bi-Parting sliding doors:
 - a. Configuration: Two sliding leaves and two full sidelites.
 - b. Traffic Pattern: Two-way.
 - c. Emergency Breakaway Capability: Sliding leaves only.
 - d. Mounting: Between jambs
- C. Activation Devices: Activate doors by the following equipment:
 - 1. Microwave-scanner two-way motion detectors.
 - 2. Infrared-scanner threshold presence detector.
 - 3. Photoelectric beam hold-open detector.
 - 4. Wall push-plate switch.
 - 5. Wall push-button switch.
 - 6. Key switch.
- D. Operator Safety Devices: Control door opening and closing by the following equipment:
 - 1. Control mat.
 - 2. Infrared-scanner presence detector.
 - 3. Photoelectric beams.

2.04 COMPONENTS

- A. Glass Panel and Rail Doors and Sidelites: Manufacturer's standard 1-3/4-inch- thick extruded-aluminum tubular rail members. Rail members to be specifically designed by automatic entrance manufacturer for use with glass panel door systems.
 - 1. Top Rail: 5 1/2 inch nominal height.
 - 2. Bottom Rail: 4 inch nominal height.
 - 3. Glazing: Provide glazing for sliding automatic entrance doors as follows:
 - a. Provide 1/4 inch clear safety glass, fully tempered, with polished edges, complying with ANSI Z97.1 and CPSC 16 CFR 1201 for Category II materials.
- B. Framing Members: Fabricate from extruded aluminum or formed-aluminum sheet or plate.
 - 1. Main Extrusions: Minimum wall thickness of 0.125 inch.
 - 2. Extruded Glazing Stops and Applied Trim: Minimum wall thickness of 0.062 inch.
- C. Headers: Fabricated from extruded aluminum or formed-aluminum sheet or plate. Conceal operator and roller track in header, providing access by means of hinged or removable access panel to permit service and adjustment. Secure panel to prevent unauthorized access.
 - 1. Concealed: Fabricate header to match depth of framing and to extend full width of door opening.
 - 2. Capacity: Capable of supporting doors up to 200 lb per leaf over spans up to 14 feet without intermediate supports.
- D. Carrier Assembly and Overhead Roller Track: Manufacturer's standard carrier assembly that allows vertical adjustment; consisting of nylon- or delrin-covered ball-bearing-center steel wheels operating on a continuous roller track, or ball-bearing-center steel wheels operating on a nylon- or delrin-covered continuous roller track. Support doors from carrier assembly by cantilever and pivot assembly.
 - 1. Rollers: Minimum two ball-bearing roller wheels and two antirise rollers for each active leaf.
- E. Sills: Manufacturer's standard sill members and bottom guide system, with stainless-steel ball-bearing-center roller wheels, and threshold and configuration indicated below:
 - 1. Configuration: Continuous standard tapered extrusion double bevel threshold across door opening and inverted, roller-guide track system at sidelites.
 - a. All thresholds to conform to details and requirements for code compliance.

- F. Signage: Comply with ANSI/BHMA A156.10.

2.05 DOOR OPERATORS

- A. General: Provide operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated. Comply with the following:
 - 1. Type: Power operated, complying with ANSI/BHMA A156.10.
 - 2. Connections: Provide connections for power and control wiring.
 - 3. Adjustment Features: Operators shall be fully adjustable without removing entrance doors, as follows:
 - a. Adjustable speed, including opening, closing, back check, and latch check.
 - b. Adjustable time delay for length of time door remains open.
 - 4. Microprocessor Control: System that automatically defines and sets opening and closing parameters.
 - 5. On/Off Feature: Provide on/off/hold-open switch to control electric power to operator.
- B. Electromechanical Operators: Self-contained overhead unit powered by a minimum of 1/4 horsepower, permanent-magnet DC motor with gear reduction drive, microprocessor controller and encoder. Provide for manual sliding when power is off. Provide operator action as indicated.
 - 1. Open/Closing Mechanism: Soft-start, power operated.
 - 2. Mounting: Concealed.

2.06 ACTIVATION AND SAFETY DEVICES

- A. Microwave-Scanner Motion Detector: Self-contained motion detector consisting of a microwave-scanner sensing device to activate door operator. Sensing device shall be adjustable to provide detection patterns and sensitivity equivalent to those required for control mats. Provide time delay for closing set at no less than 1.5 seconds. Provide metal or plastic housing with black finish for sensing device.
- B. Infrared-Scanner Presence Detector: Self-contained scanner detector consisting of an infrared presence-sensing device to activate door operator. Sensing device shall be adjustable to provide detection patterns and sensitivity equivalent to those required for control mats. Provide metal or plastic housing with black finish for sensing device.
- C. Photoelectric-Beam Control System: Manufacturer's standard horizontal photoelectric-beam system, arranged as indicated.
- D. Wall Push-Plate Switch: Manufacturer's standard semi-flush, wall-mounted, door control switch; consisting of round or square, flat push plate; of material indicated; and controlling actuator mounted in recessed junction box. Provide engraved message as indicated.
 - 1. Material: Stainless steel.
 - 2. Message: International symbol of accessibility and "Push to Open."
- E. Key Switch: Manufacturer's standard recess-mounted, door control switch; consisting of key-controlled on/off/hold-open actuator, stainless-steel cover plate, and junction box.
- F. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

2.07 HARDWARE

- A. General: Refer to Division 8 Section "Door Hardware" for requirements for hardware items other than those indicated to be provided by automatic entrance door manufacturer.

- B. Heavy-Duty Hardware: Provide units as indicated in size, number, and type recommended by manufacturer for entrances required. Finish exposed parts to match door finish, unless otherwise indicated.
- C. Emergency Breakaway Hardware: Provide release hardware that allows panel to swing out in the direction of egress to a full 90 degrees from any position in the sliding mode. Maximum force to open panel shall be 50 lbf according to ANSI/BHMA A156.10. Interrupt operation of breakaway panel operator while in the breakaway mode.
- D. Deadlocks: Manufacturer's standard deadbolt operated by exterior cylinder and interior thumb turn; with minimum 1 inch long throw bolt; ANSI/BHMA A156.5, Grade 1.
 - 1. Cylinders: Provide BEST lock cylinders, with core and key.
 - 2. Entrances with Glass Panel and Rail Doors:
 - a. Locking: Provide independent locks incorporated into the bottom rails of the sliding door panel that, when engaged, automatically extend flush bolts into the door threshold.
 - 3. Provide two locks for bi-parting doors.
- E. Sliding Weather Stripping: Manufacturer's standard replaceable weather stripping of wool, polypropylene, or nylon woven pile, with nylon-fabric or aluminum-strip backing, complying with AAMA 701. Sliding weather stripping includes stripping at jamb, head, and meeting rails where there is no stop or lap to receive compression weather stripping.

2.08 FABRICATION

- A. General: Fabricate automatic entrance door system components to designs, sizes, and thicknesses specified and to comply with indicated standards.
- B. Prefabrication: Provide automatic entrance doors as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
 - 1. Do not drill and tap for surface-mounted hardware items until time of installation at Project site.
 - 2. Perform fabrication operations, including cutting, fitting, forming, drilling, and grinding of metalwork in manner that prevents damage to exposed finish surfaces. For hardware, perform these operations before applying finishes.
 - 3. Form shapes with sharp profiles, straight and free of defects or deformations, before finishing.
 - 4. Prepare components to receive concealed fasteners and anchor and connection devices.
 - 5. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
- C. Welding: Weld components to comply with referenced AWS standard. Weld before finishing components to greatest extent possible. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- D. Glazing Channels: Provide minimum clearances for thickness and type of glass indicated according to GANA's "Glazing Manual."
- E. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- F. Hardware: Install hardware, except surface-mounted hardware, at fabrication plant. Remove only as required for final finishing operation and for delivery to and installation at Project site.
- G. Doors: Fabricate doors in profiles indicated. Reinforce as required to support imposed loads and for installing hardware. Factory assemble door and frame units.
 - 1. Exterior Doors: Provide compression weather stripping at fixed stops. At locations without fixed stops, provide sliding weather stripping retained in adjustable strip mortised into door edge.

- H. Framing: Fabricate tubular and channel frame assemblies in configuration indicated, with welded or mechanical joints according to manufacturer's standards. Provide subframes and reinforcement of types indicated or, if not indicated, as needed for a complete system to support required loads.
 - 1. Exterior Framing: Fabricate components to drain water passing joints and condensation and moisture occurring or migrating within the system to the exterior. Provide anchorage and alignment brackets for concealed support of assembly from the building structure. Allow for thermal expansion of exterior units.

2.09 ALUMINUM FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- C. Finish aluminum automatic entrance door system components to match adjacent aluminum curtain wall or storefront.
- D. Class II, Clear Anodic Finish: AA-M12C22 A31 complying with AAMA 611.
 - 1. Finish: mechanical, nonspecular as fabricated; chemical: etched, medium matte.
 - 2. Anodic Coating: Class II, clear coating not less than 0.4 mils thick.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, header support, and other conditions affecting performance of automatic entrance doors.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Comply with automatic entrance door manufacturer's written installation instructions, unless more stringent requirements are indicated. Do not install damaged components. Fit frame joints to produce hairline joints free of burrs and distortion. Rigidly secure nonmovement joints. Seal joints watertight.
- B. Metal Protection: Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Entrances: Install entrances plumb and true in alignment with established lines and grades without warp or rack of framing members and doors. Anchor securely in place. Lubricate operating hardware and other moving parts.
 - 1. Install surface-mounted hardware using concealed fasteners to greatest extent possible.
 - 2. Set tracks, header assemblies, operating brackets, and guides level and true to location with anchorage for permanent support.
 - 3. Install components to drain water passing joints and condensation and moisture occurring or migrating within the system to the exterior.
- D. Activation and Safety Devices: Install control devices and wiring, including connections to door operators, as follows:
 - 1. Microwave-Scanner Motion Detectors: Install scanners on both interior and exterior sides of each sliding automatic entrance door.

2. Infrared-Scanner Presence Detectors: Install scanners overhead in door header of each sliding automatic entrance door as indicated.
 3. Wall Switches: Provide push plates on both sides of opening as indicated.
- E. Glazing: Comply with installation requirements with published recommendations of glass product manufacturer.
- F. Sealants: Comply with requirements in Section 07 92 00 - "Joint Sealants" for installing sealants, fillers, and gaskets.
1. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction, unless otherwise indicated.
 2. Seal frame perimeter with sealant to provide weathertight construction.

3.03 FIELD QUALITY CONTROL

- A. Inspection: After completing installation, a factory trained inspector certified by the American Association of Automatic Door Manufacturers shall test and inspect each automatic entrance door for compliance with applicable ANSI/BHMA standards.
1. Inspection Report: Submit report in writing to Architect and Contractor within 24 hours after inspection.
- B. Repair or remove and replace Work that does not comply with requirements.
- C. Adjust door operators, controls, and hardware for smooth and safe operation and for weathertight closure.

3.04 CLEANING AND PROTECTION

- A. Clean glass and aluminum surfaces promptly after installation. Remove excess glazing and sealant compounds, dirt, and other substances. Repair damaged finish to match original finish.
- B. Provide final protection and maintain conditions, including limiting construction traffic, that ensure automatic entrance doors are without damage or deterioration at time of Substantial Completion.

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SECTION 08 62 13

UNIT SKYLIGHTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes factory-assembled fixed unit skylights for installation in flat roof areas.
 - 1. Type: Double-glazed, self-flashing integral-curb units.
- B. Related Sections include the following:
 - 1. Section 07 54 23 - "TPO Membrane Roofing" for integration of roof membrane at unit skylights.

1.02 REFERENCES

- A. National Fenestration Rating Council (NFRC).
 - 1. 100 - Procedure for Determining Fenestration Product U-Factors.
 - 2. 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance of Normal Incidence.
- B. International Code Council (ICC).
 - 1. 2021 International Building Code (IBC).
 - 2. 2021 International Energy Conservation Code (IECC).

1.03 SUBMITTALS

- A. Product Data: For unit skylights. Include construction details, material descriptions, dimensions of individual components and profiles, finishes and attachments to other Work.

1.04 QUALITY ASSURANCE

- A. Code Conformance: Provide ICC-ES or equivalent ICBO listing for skylight units listed as approved by municipality of jurisdiction and meeting requirements of IBC Section 2405 and IECC Section C402.
- B. Fall-Protection: Provide security bar grills to withstand human impact of 200 lbs. in accordance with O.S.H.A. Regulations 29 CFR 1910.29(e)(1).

1.05 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of unit skylights that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:
 - 1. Uncontrolled water leakage.
 - 2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 3. Thermal breakage of polycarbonate glazing.
- B. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Unit Skylights: Basis-of-Design product is based on Acralight Solar unit skylights.
 - 1. Model: 4896-A-S-SFIC2-AC
- B. Subject to compliance with requirements, acceptable manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Skyco Skylights 4896-SF-A-SPIR-MF; Kingspan ESR-3837
 - 2. Model 297; Plasteco.
 - 3. Model: 4896-SF-2-P-TB-MF-WT; Sunweld, Carlisle Syntec.

2.02 UNIT SKYLIGHTS

- A. General: Factory-assembled, integral-curb, deck-mounted units that include glazing, glazing retainers, gaskets, and inner frames and that are capable of withstanding design loads indicated.
 - 1. Height: 12 inches.
 - 2. Deck Flange Width: 2 inches minimum.
 - 3. Curb Insulation: Manufacturer's standard rigid or semi-rigid type, 1 1/2" thick.
 - 4. Frame Finish: Standard mill finish.
- B. Unit Shape and Size: Rectangular, 48-by-96-inch inside curb.
- C. Acrylic Glazing: ASTM D 4802, thermoformed, monolithic acrylic-plastic or polycarbonate sheets as standard with manufacturer.
 - 1. Double-Glazing Profile: Double-dome, insulated-glazing type.
 - a. Outboard Glazing: Tinted or translucent with Low-E energy reduction coating.
 - b. Inboard Glazing: Clear prismatic acrylic.
 - c. Maximum Solar Heat Gain Coefficient (SHGC): 0.35.
 - d. Maximum Thermal U-value: 0.65.
- D. Aluminum Frame Components:
 - 1. Sheets: ASTM B 209, alloy and temper to suit forming operations and finish requirements but with not less than the strength and durability of alclad alloy 3005-H25.
 - 2. Extruded Shapes: ASTM B 221, alloy and temper to suit structural and finish requirements but with not less than the strength and durability of alloy 6063-T52.
 - 3. Construction: Mitered frame with full-penetration welded corners of curb and retaining frames.
 - a. Frame Cap: One-piece welded frame, designed to allow drainage over roof counter-flashing.
- E. Security Grilles: Painted, 1/2-inch diameter, hardened steel bars spaced not more than 6 inches o.c. in each direction, welded into a one-piece mat and perimeter frame.

2.03 INSTALLATION MATERIALS

- A. Elastomeric Sealant: ASTM C 920; Type S; Grade NS; as recommended by unit skylight manufacturer.
- B. Deck Fasteners: Noncorrosive steel as recommended by unit skylight manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Coordinate unit skylight installation with installation of substrates, roof insulation, roofing, and flashing as required to ensure that each element performs properly and are waterproof and weathertight.
 - 1. Unless otherwise indicated, install unit skylights according to construction details of NRCA's "The NRCA Roofing and Waterproofing Manual."

- B. Anchor unit skylights securely to supporting roof deck framing to withstand 30 psf up-lift pressure.
- C. Set unit skylight flanges in bed of approved roofing sealant to form a seal, unless otherwise indicated.
- D. Install curb counter-flashing to produce waterproof overlap with roofing and skylight cap flashing.

3.02 CLEANING

- A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings.

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SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes: Hardware and related items for interior and exterior doors, other than specified in other Sections.
 - 1. Commercial door hardware for swinging doors.
 - 2. Cylinders for aluminum doors specified in other Sections.
 - 3. Electrified door hardware.

1.02 SYSTEM DESCRIPTION

- A. Door Hardware: Furnish hardware components that are new, free of defects or damage, of proper design for use in doors and frames of the thicknesses, profile, performance grade and similar requirements indicated, complete with accessories as necessary for proper installation and function.
- B. Hardware Coordination: Hardware components shall be coordinated by an Architectural Hardware Consultant, certified by DHI, for proper installation and function with doors, frames, and related work to ensure proper size, hand, finish and assembly of all door hardware components regardless of omissions or conflicts with information in the Contract Documents.

1.03 SUBMITTALS

- A. Door Hardware Sets: Submit schedules and product data of each type of hardware required for Project, in accordance with Section 01 10 00. Submit three (3) copies in DHI format, that includes the following:
 - 1. Identification number, location, hand, fire-rating, and material of each door and frame. Use same scheduling sequence and format and door numbers as in the Contract Documents.
 - 2. Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
 - 3. Cut sheets with complete designations of every item required for each door or opening including name and manufacturer.
 - 4. Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - 5. Mounting locations and templates for door hardware to enable proper and accurate sizing and locations of cutouts for hardware.
 - 6. Door and frame sizes, finish and materials.
 - 7. List of related door devices, supplied by others, as specified in other Sections.
- B. Electrified Hardware: Submit shop drawings and details, indicating the following:
 - 1. Description of each electrified door hardware function, including location, sequence of operation, and interface with other building control systems.
 - 2. Wiring Diagrams: Power, signal, and control wiring that include the following:
 - a. Point-to-point wiring diagram.
 - b. Riser diagram.
 - c. Elevation of each door.
 - 3. Sequence of Operation: Describe the operation of doors controlled by electrified door hardware. Include description of component functions that occur in the following situations: authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit.

- C. Keying: Provide construction cores that are replaceable by permanent cores without cylinder removal.

- D. Operating and Maintenance Data: Submit in accordance with Section 01 77 00 – Project Closeout. Provide Owner with Manufacturer's parts list and maintenance instructions for each type of hardware supplied and necessary wrenches and tools required for proper maintenance of hardware.
- E. Fire-Rated Door Certification:
 - 1. Where applicable, submit certification that hardware for fire rated doors and frames that will comply with UL 10C (positive pressure testing) as required by 2009 IBC Section 715.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel trained and approved by lock manufacturer.
 - 1. Installer's responsibilities include supplying and installing door hardware and providing a qualified Architectural Hardware Consultant available during the course of the Work to consult with Contractor, Architect, and Owner about door hardware and keying.
 - 2. Installer shall have warehoused inventory in Project's vicinity.
- B. Standards: Comply with the following:
 - 1. ANSI/BHMA A156, Door Hardware Standards.
 - 2. DHI, Door Hardware Institute.
 - 3. NFPA 80, Fire Doors and Windows.
 - 4. NFPA 101, Life-Safety Code, for egress doors.
 - 5. NFPA 70, National Electric Code.
 - 6. UL Standard 305 - Panic Hardware.
- C. Regulatory Requirements:
 - 1. Comply with the following:
 - a. 2009 ICC/ANSI A117.1, "Accessible and Usable Buildings and Facilities."
 - b. 2010 ADA "Standards for Accessible Design" and ADA Guidelines, as applicable.
 - c. 2021 International Building Code, Chapter 11.
 - 2. Any item furnished or installed that does not meet code requirements shall be removed and proper items substituted at no additional cost or expense to the Owner.
 - 3. Provide hardware which has been tested and listed by U.L. for the types and sizes of doors required, and which complies with the requirements of the doors and frame labels.
 - 4. Hardware on all doors leading to or from normally unlocked electrical rooms, service stairs, and dock areas which represent a hazard to the blind, shall have knurling finish on the door lever, handle, or bar which will alert the user to potential hazards.
- D. Fire-Rated Openings: Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80 and No. 101, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
 - 1. Where panic exit devices are required on fire-rated doors, provide supplementary marking on door U.L. Label indicating "Fire Exit Hardware".
- E. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1. Provide electrified door hardware and related components from a single manufacturer and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction that are acceptable to perform electrical modifications and connections.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Package each item of hardware in original and individual containers, complete with all necessary fastenings, keys, instructions, and templates for mortising tools.
 - 1. Mark each container with its item number corresponding to the item number on the approved finish hardware schedule in DHI format shall accompany each shipment.
- B. When hardware must be installed at the factory, the hardware supplier shall send all such needed items to the respective supplier for their use in installation.

- C. Deliver keys and permanent cores to Owner by registered delivery service.

1.06 COORDINATION

- A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- B. Electrical System Rough-in: Coordinate layout and installation of electrified door hardware with connections to power supplies.

1.07 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of operators and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
 - 2. Warranty Period: 2 years from date of Substantial Completion, except as follows:
 - a. Closers: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section and Door Hardware Sets indicated on Drawings or scheduled at the end of this Section.
 - 1. Hardware Sets: Provide quantity, item, size, finish indicated, and named manufacturers' products.
 - 2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

2.02 HINGES

- A. General: BHMA A156.1, five-knuckle, steel or stainless steel material, fabricated to template with flat button tips, non-rising loose steel pins, and beveled or non-beveled inner edge.
 - 1. Pins: Non-removable for exterior out-swinging doors.
 - 2. Quantity per Door Leaf: Provide the following, unless otherwise indicated:
 - a. Three Hinges: For doors less than 90 inches in height.
 - b. Four Hinges: For doors 91 inches or more in height.
 - 3. Hinge Size: 4-1/2 inches x 4-1/2 inches, square corners, of sufficient width to clear trim.
 - 4. Hinge Weight: Unless otherwise indicated, provide the following:
 - a. Type 1 (Interior Doors): Plain bearing, steel, standard-weight hinges.
 - b. Type 2 (Doors with Closers): Antifriction ball-bearing steel, standard-weight hinges.
 - c. Type 3 (Exterior Doors): Heavy-weight, ball-bearing stainless steel hinges.
 - 5. Template Dimension Requirements: BHMA A156.7, except for hinges and pivots to be installed entirely into wood doors and frames, provide only template-produced units.
 - 6. Fasteners: Comply with the following:
 - a. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 - b. Wood Screws: For wood doors and frames.
 - c. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.
- B. Pivots and Pivot Hinges:
 - 1. Pivots: BHMA A156.4.

- C. Offset Continuous Hinges: BHMA A156.26, Grade 1, certified continuous geared hinge with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepared for electrical rough-in.
- D. Electric Hinges:
 - 1. Electric Through-Wire: BHMA A156.1, Grade 1.

2.03 LOCKS AND LATCHES

- A. General Requirements: Lock function and descriptions indicated in door hardware sets to comply with the following:
 - 1. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
 - 2. Electrified Locking Devices: BHMA A156.25.
 - 3. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - a. Mortise Locks: Minimum 3/4-inch latch-bolt throw.
 - b. Deadbolts: Minimum 1-inch bolt throw.
 - 4. Backset: 2-3/4 inches, unless otherwise indicated.
 - 5. Strikes: 16 gauge strike with strike box for each latch-bolt or lock-bolt, with curved lip extended to protect frame, finished to match door hardware set, and as follows:
 - a. Strikes for Mortise Locks and Latches: BHMA A156.13.
 - b. Provide wrought boxes with strikes for wood doors or wood trim.
 - c. Provide strikes with extended lip to protect trim from being marred by latch bolt.
- B. Mechanical Cylinder Locks: BHMA A156.2, Grade 1; Series 4000, with interchangeable cores. Acceptable Products:

1. Bored Locks:	<u>Schlage</u>	<u>Best</u>	<u>Sargent</u>
a. Lock-Lever Trim:	ND-RHO	93K-15D	10-L
- C. Electric Locks: BHMA A156.23; electrically powered, of strength and configuration indicated; with electromagnet attached to frame and armature plate attached to door.
 - 1. Type: Full exterior or full interior, as required by application indicated.
 - 2. Holding Force Rating: 1500 lbf.

2.04 EXIT DEVICES

- A. Exit Devices: BHMA A156.3, Grade 1.
 - 1. Product: Von Duprin; Series 98.
- B. Panic Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
 - 1. Outside Trim: Lever with cylinder, material, finish to match locksets and latchsets.

2.05 EXIT ALARMS

- A. Exit Alarms: BHMA A156.3, Grade 1.
 - 1. Product: Detex; V40 x EX.

2.06 ELECTRIC STRIKES

- A. Standard: BHMA A156.31, Grade 1, 24 volt DC strike with standard lip and strike opening with power supply converting 110 volt AC to 24 volt DC. Provide audible sound when strike releases.
 - 1. Product: Von Duprin; 6000 Series.

2.07 LOCK CYLINDERS

- A. Cylinders: BHMA A156.5, Grade 1A, listed and labeled as complying with requirements in UL 437. Manufacturer's standard tumbler type, constructed from brass or bronze and complying with the following:
 - 1. Number of Pins: Six pin interchangeable cores.
 - 2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
 - 3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 4. Bored-Lock Type: Cylinders with tailpieces to suit locks.
- B. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 - 1. Removable Cores: Core insert, removable by use of a special key; for use with specified manufacturer's cylinder.
- C. Construction Keying: Comply with the following:
 - 1. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.
 - 2. Construction Cores: Provide construction cores that are replaceable by permanent cores.
 - a. Furnish permanent cores to Owner for installation at project close-out.

2.08 CLOSERS

- A. Surface Closers: BHMA A156.4, Grade 1, rack-and-pinion hydraulic type; with adjustable sweep and latch speeds controlled by key-operated valves; with forged-steel main arm; enclosed in full cover; complying with the following:
 - 1. Type: Regular parallel folding arm.
 - 2. Backcheck: Adjustable, effective between 60 and 85 degrees of door opening.
 - 3. Cover Material: Aluminum.
 - 4. Provide type of arm and adapter shoes required for closer to be located on hinge side of door.
 - 5. Manufacturer: LCN 4041.
- B. Accessibility Requirements: Comply with the following maximum opening-force requirements:
 - 1. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
 - 2. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
- C. Concealed Closers: BHMA A156.4, Grade 1.
- D. Coordinators: BHMA A156.3.

2.09 STOPS AND HOLDERS

- A. Stops and Bumpers: BHMA A156.16, Grade 1.
 - 1. Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Locate wall bumpers to prevent lockset lever or closer from touching wall. Walls to receive proper backing for wall bumpers.
- B. Acceptable Products:
 - 1. Door Stops:

	<u>Ives</u>	<u>Trimco</u>	<u>Rockwood</u>
a. Wall Stop:	WS401CVX	1270CX	401
b. Floor Stop:	FS436	1211	441H
- C. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch; fabricated for drilled-in application to frame; 3 at each jamb of single doors, 2 at each jamb of double doors. Not required on doors having weatherstrip or seals.

2.10 DOOR GASKETING

- A. Gasket Seals: BHMA A156.22, continuous weatherstrip gasketing on exterior doors and smoke or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

1. Air Leakage: Not to exceed 0.50 cfm per foot of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.
- B. Weatherstrip Gaskets: Compressible, teardrop shape vinyl with adhesive strip. Apply to head and jamb, forming seal between door and frame.
- C. Door Bottom Sweeps: Clear anodized aluminum trim with neoprene or silicone rubber inserts. Apply to bottom of door, forming seal with threshold when door is closed. Provide only those units where seal strips are easily replaceable and readily available from manufacturer.
- D. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled for smoke-control ratings indicated, based on testing according to UL 1784. Apply to head and jamb, forming seal between door and frame.
 1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.

2.11 THRESHOLDS

- A. Thresholds: BHMA A156.21, mill finish aluminum, beveled raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.

2.12 OPERATING TRIM

- A. Push/Pulls and Plates: BHMA A156.6, 630 finish unless otherwise scheduled.
 - a.

2.13 KICK PLATES

- A. Metal Protective Trim Units: BHMA A156.6, 0.050 thick x 10" high, 630 finish, Type 304 stainless steel, beveled on four edges. 2 inches less than door width.

2.14 DOOR BOLTS

- A. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 1. Fire-Rated Surface Bolts: Minimum 1-inch throw; listed and labeled for fire-rated doors.
- B. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1; designed for mortising into door edge.

2.15 MISCELLANEOUS HARDWARE

- A. Knox Box: Model 3200-R, 4"W x 5"H x 3-1/4" deep with 7"W x 7"H flange, black powder coat finish.
- B. Rain Drip Caps: Aluminum drip profile, single length over full width of door frame head.
- C. Door Viewer: 626 finish or equal. Mount 60 inches above floor, centered horizontally in door.

2.16 KEYING

- A. Door Locks: Master key all locksets and cylinders as directed by Owner. Provide interchangeable cores for all locksets and cylinders. All locksets and cylinders to have temporary brass construction cores.
 1. Supply 3 keys for each lock.
- B. Supply 10 additional master keys.

2.17 FINISHES

- A. Finishes: BHMA 156.18, as follows, unless scheduled otherwise:
 - 1. Exterior Hinges: BHMA 630 (US32D) satin stainless steel.
 - 2. Interior Hinges: BHMA 652 (US26D) satin chromium plated steel.
 - 3. Locksets: BHMA 626 (US26D) satin chromium plated brass.
 - 4. Push Plates & Pulls: BHMA 630 (US32D) satin stainless steel.
 - 5. Closers: BHMA 689 (US28) aluminum painted.
 - 6. Wall and Floor Stops: BHMA 626 (US26D) satin chromium plated brass.
 - 7. Magnetic Holders: BHMA 628 (US28) anodized satin aluminum.
 - 8. Sweeps: BHMA 628 (US28) anodized satin aluminum.
 - 9. Thresholds: mill aluminum.
 - 10. Gaskets and Silencers: Grey.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance. Examine rough-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

3.02 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to SDI 107.
- B. Wood Doors: Comply with DHI A115-W Series.

3.03 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in other Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- C. Boxed Power Supplies: Locate power supplies above accessible ceilings or as otherwise indicated on approved submittals.
 - 1. Configuration: Provide the least number of power supplies required to adequately serve doors with electrified door hardware.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Section 07 92 00 "Joint Sealants."

3.04 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
1. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 30 degrees.
 2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 3. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches from the latch, measured to the leading edge of the door.
- B. Occupancy Adjustment: Approximately three months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.05 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.06 HARDWARE SCHEDULE

- A. Manufacturers acronyms as abbreviated on Schedules are listed as follows:
- | | |
|------------------------|------|
| 1. Ives | IVES |
| 2. Schlage | SCH |
| 3. Best | BEST |
| 4. Von Duprin | VON |
| 5. Adams Rite | ADAM |
| 6. Rockwood | RKWD |
| 7. LCN | LCN |
| 8. Besam | BESM |
| 9. Glynn Johnson | GLYN |
| 10. Horton | HORT |
| 11. Pemko | PMKO |
| 12. Securitron | SCE |
| 13. By Owner or Others | BO |

HW SET: 01 SLIDING AUTOMATIC ENTRANCE

DOOR NO: 100

EACH TO HAVE:

1	EA	IC CORE	C181	626	BEST
---	----	---------	------	-----	------

NOTE: SEE SPEC SECTION 08 42 29 FOR BALANCE OF DOOR HARDWARE .

HW SET: 02 WAREHOUSE EXIT (HM w/HM frame)

DOOR NO 005, 009, 010, 011, 012, 013, 014, 015, 017, 021, 030, 031, 032

EACH TO HAVE:

3	EA	HINGES	5BB1HW 4.5 X 4.5 NRP	630	IVES
1	EA	PANIC-BAR EXIT DEVICE	99NL x 99GNL TRIM	626	VON
1	EA	RIM CYLINDER	80-159	626	SCH
1	EA	CYLINDER IC CORE	C181	626	BEST
1	SET	CLOSER/ STOP	4040 XP x EDA	689	LCN

1	EA	WEATHERSTRIP	303AV	GRY	PMKO
1	EA	DOOR SWEEP	315CN	AL	PMKO
1	EA	THRESHOLD	271A	AL	PMKO
1	EA	RAIN DRIP	346C	AL	PMKO
1	EA	DOOR VIEWER	698	626	IVES

HW SET: 03 RESTROOM (wood w/alum frame – single)

DOOR NO: 106, 108, 113, 115

EACH TO HAVE:

3	EA	HINGES	5BB1 4.5 x 4.5 NRP	652	IVES
1	EA	PUSH PLATE	8200 x 6" x 16"	626	IVES
1	EA	DOOR PULL	8103EZ x 12"	626	IVES
1	EA	PULL PLATE	8300 x 6" x 16"	626	IVES
1	EA	SURFACE CLOSER	4040XP	689	LCN
2	EA	KICK PLATE	8400 x 10" x 34"	630	IVES
1	EA	WALL STOP	WS401CVX	626	IVES

HW SET: 04 ELECTRICAL ROOM (wood w/alum frame – single)

DOOR NO: 104, 117

EACH TO HAVE:

3	EA	HINGES	5BB1 4.5 x 4.5 NRP	652	IVES
1	EA	STOREROOM LOCK	ND80HD RHO	626	SCH
1	EA	IC CORE	C181	626	BEST
1	EA	SURFACE CLOSER	4040 XP	689	LCN
1	EA	WALL STOP	WS401CVX	626	IVES
1	SET	SEALS	SR64	GRY	IVES

HW SET: 05 MOP CLOSET (wood w/alum frame – single)

DOOR NO: 107, 114

EACH TO HAVE:

3	EA	HINGES	5BB1 4.5 x 4.5 NRP	652	IVES
1	EA	STOREROOM LOCK	ND80HD RHO	626	SCH
1	EA	IC CORE	C181	626	BEST
2	EA	KICK PLATE	8400 x 10" x 34"	630	IVES
1	EA	WALL STOP	WS401CVX	626	IVES

HW SET: 06 STORAGE (wood w/alum frame – single)

DOOR NO: 110A, 116, 102

EACH TO HAVE:

3	EA	HINGES	5BB1 4.5 x 4.5 NRP	652	IVES
1	EA	STOREROOM LOCK	ND80HD RHO	626	SCH
1	EA	IC CORE	C181	626	BEST
1	EA	WALL STOP	WS401CVX	626	IVES

HW SET: 07 OPEN OFFICE (wood w/alum frame – single)

DOOR NO: 110, 110B

EACH TO HAVE:

3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVES
1	EA	PASSAGE SET	ND10S RHO	626	SCH
1	EA	WALL STOP	WS401CCV	626	IVES

HW SET: 08 OFFICE (wood w/alum frame – single)

DOOR NO: 103, 105, 111

EACH TO HAVE:

3	EA	HINGES	5BB1 4.5 X 4.5 NRP	652	IVES
1	EA	ENTRANCE LOCK	ND50PD RHO	626	SCH
1	EA	IC CORE	C181	626	BEST
1	EA	WALL STOP	WS401CCV	626	IVES

HW SET: 09		RESTROOM (wood w/alum frame)			
DOOR NO:		109, 123			
EACH TO HAVE:					
3	EA	HINGE	5BB1 4.5 X 4.5 NRP	652	IVES
1	EA	PRIVACY SET W/INDICATOR	ND40S x RHO	626	SCH
1	EA	DOOR CLOSER	4040XP	689	LCN
1	EA	WALL STOP	WS401CCV	626	IVES
HW SET: 10		FIRE PUMP/ELECTRICAL ROOM (pair)			
DOOR NO.		001, 019			
EACH TO HAVE:					
6	EA	HINGES	5BB1 4.5 X 4.5 NRP	652	IVES
1	EA	REMOVABLE MULLION	KR4954 x 84"	SP28	VON
1	EA	MORTISE CYLINDER	80-132	626	SCH
1	EA	RIM CYLINDER	80-159	626	SCH
2	EA	PANIC-BAR EXIT DEVICE	99NL x 99GNL TRIM	626	VON
2	EA	IC CORE	C181	626	BEST
2	EA	CLOSER/ STOP	4040XP x CUSH	689	LCN
1	SET	WEATHER STRIP	303AV	GRY	PMKO
2	EA	DOOR SWEEP	315CN x 36"	AL	PMKO
1	EA	THRESHOLD	271A x 72"	AL	PMKO
1	EA	RAIN DRIP	346C x 76"	AL	PMKO
1	EA	ASTRAGAL	303AV	GRY	PMKO
HW SET: 11		OVERHEAD DOCK DOORS			
DOOR NO:		002, 003, 004,006, 007, 008, 022,023, 024, 025, 026, 027, 028, 029			
EACH TO HAVE:					
1	EA	PADLOCK	KS21D1200 x SFIC	452	SCH
1	EA	IC CORE	C181	626	BEST
		BALANCE OF HDWR. BY DOOR MFG.			
HW SET: 12		ALUMINUM EXIT (single)			
DOOR NO:		118			
EACH TO HAVE:					
1	EA	CONTINUOUS HINGE	CFM 95HD1	CL	PMKO
1	EA	OFF-SET PUSH PULL	BF15847 - 12" B1 MTG.	630	RKWD
1	EA	MORTISE DEADLOCK	MS1850S	628	ADAM
1	EA	MORTISE CYLINDER	4036-01	628	ADAM
1	EA	IC CORE	C181	628	BEST
1	EA	CYLINDER	4066-01	628	ADAM
1	EA	SURFACE CLOSER/ STOP			
HW SET: 13		ALUMINUM ENTRANCE (pair)			
DOOR NO:		018			
EACH TO HAVE:					
2	EA	CONTINUOUS HINGE	CFM 95HD1	CL	PMKO
2	EA	OFF-SET PUSH PULL	BF15847 - 12" B1 MTG.	630	RKWD
1	EA	TRESHOLD BOLT	4016-02	SS	ADAM
1	EA	HEADER BOLT	4016-30-02	SS	ADAM
1	EA	MORTISE DEADLOCK	MS1850S	628	ADAM
2	EA	MORTISE CYLINDER	4036-01	628	ADAM
2	EA	IC CORE	C181	628	BEST
2	EA	CYLINDER	4066-01	628	ADAM
2	EA	SURFACE CLOSER/ STOP	4040XP x CUSH	689	LCN
1	EA	THRESHOLD	271-72"	AL	PMKO
1	EA	DECAL	DOORS TO REMAIN UNLOCKED	BLK	RO

NOTE: WEATHERSTRIP AND DOOR BOTTOM BY ALUMINUM DOOR MANUFACTURER
 AFW Colorado / BDG 20068.100
 October 15, 2024

Door Hardware
 08 71 00 - 10

HW SET: 14**SHOWROOM WAREHOUSE (HM w/HM frame)**

DOOR NO 120

EACH TO HAVE:

3	EA	HINGES	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC-BAR EXIT DEVICE	99NL x 99GNL TRIM	626	VON
1	EA	RIM CYLINDER	80-159	626	SCH
1	EA	CYLINDER IC CORE	C181	626	BEST
1	EA	CLOSER/ STOP	4040 XP x EDA	689	LCN
1	SET	WEATHERSTRIP	303AV	GRY	PMKO
1	EA	DOOR SWEEP	315CN	AL	PMKO
1	EA	THRESHOLD	271A	AL	PMKO

HW SET: 15**ELECTRICAL ROOM EXIT (HM w/HM frame)**

DOOR NO 119

EACH TO HAVE:

3	EA	HINGES	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	PANIC-BAR EXIT DEVICE	99NL x 99GNL TRIM	626	VON
1	EA	RIM CYLINDER	80-159	626	SCH
1	EA	CYLINDER IC CORE	C181	626	BEST
1	EA	CLOSER/ STOP	4040 XP x EDA	689	LCN
1	SET	WEATHERSTRIP	303AV	GRY	PMKO
1	EA	DOOR SWEEP	315CN	AL	PMKO
1	EA	THRESHOLD	271A	AL	PMKO

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SECTION 08 81 00

GLASS AND GLAZING

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes glazing, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Glazed storefronts.
 - 2. Glazed curtain walls.
 - 3. Glazed entrances.
- B. Related Sections include the following:
 - 1. Section 08 41 23 for "Aluminum-Framed Entrances and Window Walls" for glazing of glass within aluminum-framed glazing components.
 - 2. Section 07 92 00 for "Joint Sealants" for installation of joint sealants installed with aluminum-framed systems and for sealants to the extent not specified in this Section.

1.02 DEFINITIONS

- A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Deterioration of Coated Glass: Defects developing from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking and other indications of deterioration in metallic coating.
- C. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by particles, moisture, or film on interior surfaces of glass.
- D. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delaminating material obstructing vision through glass and blemishes exceeding those allowed by referenced laminated glass standards.

1.03 PERFORMANCE REQUIREMENTS

- A. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:
 - 1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:
 - a. Design Wind Loads: Determine design wind loads applicable to Project from basic wind speed indicated in miles per hour 33 feet above grade, according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures".
- B. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 - a. Center of glass U-Value: NFRC 100 methodology using LBNL WINDOW 5.2/6.3 computer program.
 - b. Center of glass solar heat gain coefficient: NFRC 200 methodology using LBNL-35298 WINDOW 5.2/6.3 computer program.
 - c. Solar optical properties: NFRC 300.

1.04 SUBMITTALS

- A. Samples: Submit three, 12-inch x 12-inch samples of each type and color of glass indicated.
- B. Product Data and Test Reports: For each of the following types of glazing products:
 1. Insulating glass.
 2. Glazing sealants.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- B. Source Limitations for Glass: Obtain all glass products through one source from a single manufacturer for each glass type.
- C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.
- D. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.
 1. Glass Testing Agency Qualifications: An independent testing agency accredited according to the NFRC Certification Program.
- E. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
- F. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201.
 1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
 2. Where glazing units, including Kind FT glass, are specified in PART 2 articles, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.
- G. Codes and Standards: Comply with applicable provisions of the following codes, specifications and standards, unless more stringent provisions are indicated or specified:
 1. 2018 International Building Code
 2. ASTM C 1036 Standard Specification for Flat Glass
 3. ASTM C 1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
 4. ASTM C 1172 Standard Specification for Laminated Architectural Flat Glass
 5. ASTM C 1376 Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass
 6. ASTM E 2190 Standard Specification for Insulating Glass Unit Performance and Evaluation
 7. ASTM E 1300 Standard Practice for Determining Load Resistance of Glass in Buildings
 8. NFRC 100/200 National Fenestration Rating Council certification program for glass thermal and optical properties

9. ANSI Z97.1 Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings
10. CPSC 16 CFR 1201 Safety Standard for Architectural Glazing Materials

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions to prevent damage to glass and glazing materials from condensation, direct exposure to sun, or other causes.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 1. Do not install liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F.

1.08 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 1. Warranty Period: 10 years from date of Substantial Completion.
- C. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace laminated-glass units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PRODUCTS AND MANUFACTURERS

- A. Insulated Coated Glass Manufacturer (Type A): Subject to compliance with requirements, provide glass products equal to:
 1. Vision-Lite Insulating Units: Solarban 70, by PPG-Vitro Architectural Glass.
 2. Overall Unit Thickness and Thickness of Each Lite: 1 -inch and 1/4 -inch.
 3. Interspace Content and Thickness: 1/2 -inch air filled.
 4. Exterior Lite: Heat-Strengthened, Class 1 (clear) float glass.
 5. Indoor Lite: Heat-Strengthened or Annealed Class 1 (clear) float glass.
 6. Low-E Coating: Second surface.
 7. Edge Material: mill finish aluminum.
 8. Edge Sealant: black silicone.
 9. Visible Light Transmittance: 64 percent.
 10. Summer U-Value: 0.28 maximum.
 11. Solar Heat Gain Coefficient: 0.28.

- B. Insulated Coated Glass Manufacturer (Type B): Subject to compliance with requirements, provide glass products equal to:
1. Vision-Lite Insulating Units: Solarban 70, by PPG-Vitro Architectural Glass.
 2. Overall Unit Thickness and Thickness of Each Lite: 1 -inch and 1/4 -inch.
 3. Interspace Content and Thickness: 1/2 -inch air filled.
 4. Exterior Lite: Heat-Strengthened, Class 1 (clear) float glass.
 5. Indoor Lite: Heat-Strengthened or Annealed Class 1 (clear) float glass.
 6. Low-E Coating: Second surface.
 7. Acid-Etch Frit: Third surface: PPG-Vitro Pavia
 8. Edge Material: mill finish aluminum.
 9. Edge Sealant: black silicone.
 10. Visible Light Transmittance: 82 percent.
 11. Summer U-Value: 0.26 maximum.
 12. Solar Heat Gain Coefficient: 0.80
- C. Insulated Glass Manufacturer (Type C): Subject to compliance with requirements, provide glass products equal to:
1. Vision-Lite Insulating Units: Clear glass.
 2. Overall Unit Thickness and Thickness of Each Lite: 1 -inch and 1/4 -inch.
 3. Interspace Content and Thickness: 1/2 -inch air filled.
 4. Exterior Lite: Annealed, Class 1 (clear) float glass.
 5. Indoor Lite: Annealed Class 1 (clear) float glass.
- D. Mirror Glass Manufacturer (Type D): Subject to compliance with requirements, provide glass products equal to:
1. Mirror Units: Pilkington Mirropane.
 2. Indoor Lite: Tempered Class 1 (clear) float glass.
 3. Thickness: 1/4 -inch.
 4. Reflective Coating: Second surface.

2.02 PRIMARY FLOAT GLASS

- A. Float Glass: ASTM C 1036, flat glass, Type 1, Class 1 (clear) or Class 2 (tinted, heat-absorbing) and Quality q3; 1/4 thick minimum.

2.03 HEAT-TREATED FLOAT GLASS

- A. Heat-Treated Float Glass: ASTM C 1048 (annealed) or ASTM C 1036 (heat-strengthened); flat glass, Type 1, Class 1 (clear) or Class 2 (tinted) and Quality q3; 1/4 thick minimum. Fabricate by horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed.
1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites.
 2. Provide Kind FT (fully tempered) complying with ANSI Z97.1 and CPSC 16 CFR 1201, where safety glass is required.
 3. Fabrication Tolerances:
 - a. Maximum Peak-to-Valley Rollerwave: 0.008".
 - b. Maximum bow and warp: 1/32" per lineal foot.

2.04 COATED FLOAT GLASS

- A. Coated Float Glass: Heat-treated float glass complying with ASTM C 1376 for magnetically sputtered vacuum deposition coatings, and with requirements specified.
1. Provide Kind HS (heat-strengthened) coated float glass in place of coated annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites.
 2. Provide Kind FT (fully tempered) complying with ANSI Z97.1 and CPSC 16 CFR 1201, where safety glass is required.

2.05 SEALED INSULATING GLASS

- A. Insulating-Glass Units: Preassembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article.
 - 1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in "Performance Requirements" Article. Provide Kind FT (fully tempered) where safety glass is indicated.
- B. Edge Sealing System: Dual seal, with primary and secondary silicone sealants.
- C. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article.
 - 1. Provide Kind FT (fully tempered) glass lites where safety glass is indicated or required.
 - 2. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
 - 3. Sealing System: Dual seal, with primary and secondary sealants as follows:
 - a. Manufacturer's standard sealants.
 - 4. Spacer Specifications: Manufacturer's standard spacer material and construction.

2.06 ELASTOMERIC GLAZING SEALANTS

- A. General: Provide products of type indicated, complying with the following requirements:
 - 1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application.
 - 2. Colors of Exposed Glazing Sealants in contact with glass: Black
- B. Elastomeric Glazing Sealant Standard: Comply with ASTM C 920, Type S, Grade NS, Use G.

2.07 GLAZING TAPES

- A. Mastic Glazing Tape: Preformed, butyl-based elastomeric tape with a solids content of 10 percent; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended by tape and glass manufacturers for application indicated.

2.08 GLAZING GASKETS

- A. Compression Gaskets: Molded or extruded gaskets as specified in Section 08410.

2.09 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks and Spacers: Elastomeric with a Shore A durometer hardness of 85, plus or minus 5.

2.10 FABRICATION OF GLASS AND OTHER GLAZING PRODUCTS

- A. Fabricate glass and other glazing products in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing standard, to comply with system performance requirements.
- B. Grind smooth and polish exposed glass edges.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine framing glazing, with Installer present, for compliance with the following:
 - 1. Manufacturing and installation tolerances, including those for size and squareness at corners.
 - 2. Presence and functioning of drainage system.
 - 3. Minimum required face or edge-bite clearances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 TAPE GLAZING

- A. Position tapes and apply sealants in manner complying with aluminum-framing manufacturer's requirements to maintain a water-tight and self-draining window wall assembly.

3.03 GASKET GLAZING (DRY)

- A. Install compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, and allow for thermal movement. Compress gaskets to produce a weathertight seal without developing bending stresses in glass.

3.04 PROTECTION AND CLEANING

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove them immediately as recommended by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for build-up of dirt, scum, alkaline deposits, or stains; remove as recommended by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged in any way, including natural causes, accidents, and vandalism, during construction period.
- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Galvanized interior wall and ceiling framing.
- B. Related Sections include the following:
 - 1. Section 05 40 00 for "Cold-Formed Metal Framing" for exterior load-bearing metal-stud framing.

1.02 REFERENCES

- A. American Iron and Steel Institute (AISI):
 - 1. AISI S220-20 North American Specification for the Design of Cold-formed Steel Nonstructural Framing.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A 645 – Specification for Nonstructural Steel Framing Members.
 - 2. ASTM A 653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
 - 3. ASTM A 1003 – Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Framing Members.
- C. Steel Stud Manufacturers Association (SSMA):
 - 1. Product Technical Information – ICC ESR-3064P.
- D. Steel Framing Industry Association (SFIA):
 - 1. SFIA Code Compliance Certification Program.

1.01 SYSTEM REQUIREMENTS

- E. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated. Maximum allowable deflection:
 - 1. Walls receiving gypsum wallboard: L/120.
 - 2. Walls receiving Interior tile finishes: L/240.

1.03 SUBMITTALS

- A. Product Data: For each type of cold-formed metal framing product and accessory indicated.
- B. Research/Evaluation Reports: Evidence of cold-formed metal framing's compliance with current ICC evaluation reports.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, furnish products as manufactured by a member of the Steel Stud Manufacturers Association (SSMA) or Steel Framing Industry Association (SFIC). Manufacturers offering cold-formed metal framing that may be incorporated into the Work include, but are not limited to, the following:
 - 1. SCAFCO Steel Stud Co. (ICC ESR-3064P)
 - 2. CEMCO - California Expanded Metal Products Co. (ICC ESR-2620)
 - 3. Clark Dietrich Building Systems. (ICC ESR-2457)
 - 4. United Metal Products. (ICC ESR-3064P)

2.02 NON-LOAD-BEARING STEEL FRAMING MATERIALS

- A. Framing Members:
 - 1. Steel Sheet Components: Comply with ASTM C 645, 33,000 psi minimum yield strength for metal.
 - 2. Protective Coating: ASTM A 653, G40, hot-dipped galvanized, minimum zinc coating of 0.40 oz per s.f.

2.03 SUSPENSION SYSTEM COMPONENTS

- A. Tie Wire: ASTM A 641, Class 1 zinc coating, soft temper, 0.0625-inch- diameter wire, or double strand of 0.0475-inch- diameter wire.
- B. Hanger Attachments to Concrete:
 - 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
 - 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- C. Drop-Ceiling Carrying Channels: Cold-rolled, U-shaped channel fabricated from 16 ga. commercial-steel sheet and minimum 1/2-inch- wide flanges.
 - 1. Width: 2 1/2 inches.
 - 2. Horizontal Spacing: 4'-0" o.c.
- D. Hat-Shaped Furring Channels:
 - 1. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 2 1/2-inch wide; 7/8-inch or 1 1/2-inch deep.
 - a. Minimum Base Metal Thickness: 0.0179 inch.
- E. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.

2.04 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, complying with ASTM C 955, and as follows:
 - 1. Flange Width: 1 1/4 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, complying with ASTM C 955, and as follows:
 - 1. One gauge heavier in thickness than C-stud gauge.
 - 2. Flange Width: 2 inches.
- C. Slip-Type Head Track: Where indicated, provide one of the following:
 - 1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.

2. Deflection Track: Slotted steel sheet top runner with 2 1/2-inch flange, manufactured to prevent stud deflection of interior partition framing resulting from deflection of structure above; 18 gauge thickness and in width to accommodate depth of studs. Subject to compliance with requirements, provide products equal to one of the following:
 - a. SCAFCO; Slotted Track.
 - b. CEMCO; SLP-TRK.
 - c. Clark Dietrich; MaxTrack.
 - d. United Metal Products; Slip Track.
- D. Bridging Channels: Cold-rolled, U-shaped channel fabricated from 16 ga. commercial-steel sheet and minimum 1/2-inch- wide flanges.
 1. Width: 3/4 inches.
 2. Vertical Spacing: 4'-0" o.c.

2.05 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.
 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding capacity, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

3.03 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.04 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - b. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - c. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.05 INSTALLING FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install studs so flanges within framing system point in same direction.
- C. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb, unless otherwise indicated.
 - b. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
 - a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- D. Direct Furring: Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.06 METAL-STUD FRAMING DESIGNATION SCHEDULE

- A. Sheet Metal Thickness: The following table is provided as a cross-reference to non-structural steel-stud designations and traditional minimum gauge thickness of framing members:

Designation Thickness	Design Thickness (in)	Reference Gauge No.
18 mil	0.0188	25 ga
30 mil	0.0312	20 ga
33 mil	0.0346	20 ga
43 mil	0.0451	18 ga
54 mil	0.0566	16 ga

- B. Stud Designations: The following tables are provided as a cross-reference to SSMA steel-stud designations, calculated in accordance with ICC-ES AC86-15 for interior non-structural framing.
1. Web Depth Size: Indicated in decimal inches. Example: 3 5/8" equals 362; 6" equals 600, etc.
 2. Flange Depth: 2" equals 200; 1 1/4" equals 125.
 3. Shape Designation: 'S' for steel stud C-shape profile.
 4. Metal Thickness: Indicated in mil thickness and minimum steel gauge thickness.
 5. Maximum Span: L/120 deflection at 5 psf, single span, 33 ksi steel, u.n.o.
- C. Span Table: Composite wall assemblies with a single-layer of 5/8" gypsum wall board installed on each side of stud full height of wall.

STUD SIZE	MIL	GA	STUD SPACING (in. o.c.)	MAXIMUM SPAN (ft)	YIELD STRENGTH
250S125-18	18	25	16	14'-2"	33 ksi
250S125-18	18	25	24	11'-7"	33 ksi
250S125-30	30	20	16	16'-9"	33 ksi
250S125-30	30	20	24	14'-7"	33 ksi
362S125-18	18	25	16	16'-2"	33 ksi
362S125-18	18	25	24	13'-2"	33 ksi
362S125-30	30	20	16	20'-8"	33 ksi
362S125-30	30	20	24	18'-1"	33 ksi
400S125-18	18	25	16	16'-8"	33 ksi
400S125-18	18	25	24	13'-8"	33 ksi
400S125-30	30	20	16	22'-3"	33 ksi
400S125-30	30	20	24	19'-5"	33 ksi
400S200-43	43	18	16	27'-5"	33 ksi
400S200-43	43	18	24	23'-11"	33 ksi
400S200-54	54	16	16	29'-5"	50 ksi
400S200-54	54	16	24	25'-8"	50 ksi
600S125-33	18	25	16	20'-1"	33 ksi
600S125-33	18	25	24	16'-4"	33 ksi
600S125-30	30	20	16	24'-7"	33 ksi
600S125-30	30	20	24	21'-6"	33 ksi
600S200-43	43	18	16	37'-6"	33 ksi
600S200-43	43	18	24	32'-0"	33 ksi
600S200-54	54	16	16	40'-3"	50 ksi
600S200-54	54	16	24	35'-2"	50 ksi
800S200-43	43	18	16	45'-10"	33 ksi
800S200-43	43	18	24	37'-5"	33 ksi
800S200-54	54	16	16	50'-7"	50 ksi
800S200-54	54	16	24	44'-2"	50 ksi

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SECTION 09 29 00

GYPSUM BOARD

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Interior gypsum board, Level 4 finish at walls.
 - 2. Interior gypsum board, Level 5 finish at ceilings.
 - 3. Interior gypsum board ceramic tile backer board.
- B. Related Sections include the following:
 - 1. Section 07 21 16 for "Building Insulation" for insulation in gypsum board assemblies.
 - 2. Section 07 92 00 for "Joint Sealants" for acoustical sealant applications in drywall assemblies.

1.02 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C473 Standard Test Methods for Physical Testing of Gypsum Panel Products.
 - 2. ASTM C630 Standard Specification for Water-Resistant Gypsum Backing Board.
 - 3. ASTM C840 Standard Specification for Application and Finishing of Gypsum Board.
 - 4. ASTM C1396 Standard Specification for Gypsum Board.
 - 5. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - 6. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
- B. Gypsum Association (GA):
 - 1. ASTM C473 Standard Test Methods for Physical Testing of Gypsum Panel Products.
 - 2. GA-214 Recommended Levels of Gypsum Board Finish.
 - 3. GA-216 Application and Finishing of Gypsum Panel Products.

1.03 SUBMITTALS

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

1.04 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Fire-Resistance-Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory."
- B. Sound Transmission Characteristics: For gypsum board assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials bearing brand name and identification of manufacturer or supplier.

- B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.01 GYPSUM WALLBOARD

- A. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.
- B. Gypsum Wallboard: ASTM C 36.
 - 1. Regular Type:
 - a. Thickness: 5/8 inch, unless otherwise indicated
 - b. Long Edges: Tapered for prefilling.
 - 2. Type X:
 - a. Thickness: 5/8 inch.
 - b. Long Edges: Tapered for prefilling.

2.02 BACKER BOARD UNITS

- A. Glass-mat Gypsum Backer Board: Provide reinforced gypsum board units complying with ASTM C1658 and ANSI A118.9 in maximum lengths available.
 - 1. Thickness: 5/8 inch
 - 2. Width: 48 inches
 - 3. Available Products:
 - a. Certainteed Corp.; GlasRoc.
 - b. Georgia-Pacific; DensArmor Plus.
 - c. USG Corporation; Durock Glass-Mat.

2.03 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
 - 1. Material: Hot-dip galvanized steel sheet or rolled zinc.
 - 2. Shapes:
 - a. Cornerbead: Use at outside corners.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound; use at exposed panel edges.

2.04 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475.
- B. Joint Tape:
 - 1. Interior Gypsum Wallboard: Paper.
 - 2. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
 - 1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.

2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, trim flanges, and paper-faced metal trim accessories, use setting-type taping compound.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.

2.05 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
 1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- E. Thermal Insulation: As specified in Division 7 Section "Building Insulation."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLYING AND FINISHING PANELS, GENERAL

- A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.
- B. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- C. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- D. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.
 1. Space screws a maximum of 12 inches o.c. for vertical applications.
 2. Space fasteners in panels that are tile substrates a maximum of 8 inches o.c.

3.03 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's instructions.

3.04 FINISHING GYPSUM BOARD ASSEMBLIES

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, beveled edges, and damaged surface areas.
- C. Apply joint tape over board joints, except those with trim having flanges not intended for tape embedment.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840 and GA-214, for locations indicated:
 - 1. Level 1: All joints and interior angles shall have tape set in joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable at fire-taping.
 - 2. Level 2: All joints and interior angles shall have tape embedded in joint compound and wiped with a joint knife leaving a thin coating of joint compound over all joints and interior angles. Fastener heads and accessories shall be covered with a coat of joint compound. Surface shall be free of excess joint compound. Tool marks and ridges are acceptable. Joint compound applied over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.
 - 3. Level 3: All joints and interior angles shall have tape embedded in joint compound and one additional coat of joint compound applied over all joints and interior angles. Fastener heads and accessories shall be covered with two separate coat of joint compound. All joint compound shall be smooth and free of tool marks and ridges.
 - 4. Level 4: All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compounds. All joint compound shall be smooth and free of tool marks and ridges.
 - 5. Level 5: All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. A thin skim coat of joint compound or material manufactured specifically for this purpose, shall be applied to the entire surface. The finished application shall be smooth and free of tool or sanding marks and ridges.

END OF SECTION

SECTION 09 31 00

CERAMIC TILE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Ceramic porcelain wall and floor tile.

1.02 PERFORMANCE REQUIREMENTS

- A. Dynamic Coefficient of Friction: For tile installed on interior walkway surfaces, provide products with the following values as determined by testing identical products per ANSI A137.1:
 - 1. Wet Level Surfaces: Minimum 0.42.
 - 2. Step Treads: Minimum 0.50.
 - 3. Ramp Surfaces: Minimum 0.50.

1.03 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C473 Standard Test Methods for Physical Testing of Gypsum Panel Products.
 - 2. ASTM C630 Standard Specification for Water-Resistant Gypsum Backing Board.
 - 3. ASTM D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.
- D. Samples for Verification:
 - 1. Full-size units of each type and composition of tile and for each color and finish required.
 - 2. Grout samples for each type and composition of tile and for each color and finish required.
 - 3. Full-size units of each type of trim and accessory for each color and finish required.
- E. Product Certificates: For each type of product, signed by product manufacturer.
- F. Qualification Data: For Installer.
- G. Material Test Reports: For each tile-setting and -grouting product and special-purpose tile.

1.05 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain all tile of same type from one source or producer.
 - 1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.

- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
 - 1. Waterproofing.
 - 2. Joint sealants.
 - 3. Backer units.
 - 4. Metal edge strips.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- B. Store liquid emulsions and adhesives in unopened containers and protected from freezing.
- C. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.07 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.08 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 1/2 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Basis-of-Design Product: The design for each tile type is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.02 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" Article.
- C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with requirements.

- D. Factory Blending: For tile exhibiting color variations within ranges selected during Sample submittals, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- E. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless otherwise indicated.
- F. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.03 TILE PRODUCTS

- A. Manufacturers:
 - 1. See Drawings for schedule of tile and trim units.

2.04 SETTING AND GROUTING MATERIALS

- A. Manufacturers:
 - 1. C-Cure.
 - 2. Custom Building Products.
 - 3. LATICRETE International Inc.
- B. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1:
 - 1. For wall applications, provide nonsagging mortar that complies with Paragraph C-4.6.1 in addition to the other requirements in ANSI A118.1.
- C. Modified Dry-set Portland Cement Mortar (Thin Set): ANSI A118.4:
 - 1. Prepackaged dry-mortar mix combined with liquid-latex additive.
 - a. For wall applications, provide nonsagging mortar that complies with TE designation in addition to the other requirements in ANSI A118.4.
- D. Polymer-Modified Tile Grout: ANSI A118.7, color as indicated.
 - 1. Polymer Type: Either ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
 - a. Unsanded grout mixture for joints 1/8 inch and narrower.
 - b. Sanded grout mixture for joints 1/8 inch and wider.
- E. Standard Sanded Cement Grout: ANSI A118.6, color as indicated.
- F. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored aggregate as required to produce color indicated.
- G. Standard Unsanded Cement Grout: ANSI A118.6, color as indicated.
 - 1. Unsanded grout mixture for joints 1/8 inch and narrower.
 - 2. Sanded grout mixture for joints 1/8 inch and wider.

2.05 TRANSITION MATERIALS

- A. Metal Edge and Transition Strips: Extruded zinc, aluminum, or roll-formed stainless steel edge strips, height as indicated; with integral perforated anchoring leg for setting the strip into the tile setting material.
 - 1. Floor Tile to Concrete Transition Strip:
 - a. Blanke; Edge Reducer Trim.
 - b. Schluter; Reno-U.
 - 2. Floor Tile to Carpet Transition Strip:
 - a. Blanke; Carpet Trim.

- b. Schluter; Reno-TK.
- 3. Floor Expansion Control Joint Strip:
 - a. Blanke; HD Expansion joint.
 - b. Schluter; Dilex-KSN.
- 4. Wall Tile Wainscote Edge Strip:
 - a. Blanke; Triangle Trim.
 - b. Schluter; Rondec-DB.
- 5. Wall Tile Corner Edge Strip:
 - a. Blanke; Corner Profile.
 - b. Schluter; Quadec.
- 6. Wall Tile Edge Termination Strip:
 - a. Blanke; Cubeline.
 - b. Schluter; Jolly.

2.06 ELASTOMERIC SEALANTS

- A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 7 Section "Joint Sealants."
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.
- C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures.
 - 1. Available Products:
 - a. Dow Corning Corporation; Dow Corning 785.
 - b. GE Silicones; SCS 1700.
 - c. Tremco, Inc.; Tremsil 200.
- D. Multipart, Pourable Polyurethane Sealant: ASTM C 920; Type M; Grade P; Class 25; Uses T, I, and, as applicable to joint substrates indicated, O.
 - 1. Available Products:
 - a. Sika Corporation; Sikaflex-2c SL.
 - b. Pecora Corporation; NR-200 Urexpan.
 - c. Tremco, Inc.; Vulkem 445SSL.

2.07 BACKER BOARD UNITS

- A. Glass-mat Gypsum Backer Board: Provide reinforced gypsum board units complying with ASTM C1658 and ANSI A118.9 in maximum lengths available.
 - 1. Thickness: 5/8 inch
 - 2. Width: 48 inches
 - 3. Available Products:
 - a. Certainteed Corp.; GlasRoc
 - b. Georgia-Pacific; DensArmor Plus
 - c. USG Corporation; Durock Glass-Mat

2.08 MISCELLANEOUS MATERIALS

- A. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- B. Grout Sealer: Manufacturer's standard[silicone] product for sealing grout joints that does not change color or appearance of grout.
 - 1. Available Products:

- a. C-Cure; Penetrating Sealer 978.
- b. Custom Building Products; Grout Sealer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
 - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.
 - 3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.
- B. Provide concrete substrates for tile floors installed with adhesives or thin-set mortar that comply with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards.
 - 1. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions. Use product specifically recommended by tile-setting material manufacturer.
 - 2. Remove protrusions, bumps, and ridges by sanding or grinding.
- C. Blending: For tile exhibiting color variations within ranges selected during Sample submittals, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- D. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.03 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned

joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

- E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
- F. Lay out tile wainscots to next full tile beyond dimensions indicated.
- G. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Locate joints in tile surfaces directly above joints in concrete substrates.
 - 2. Prepare joints and apply sealants to comply with TCA EJ171 installation methods.
- H. Grout tile to comply with requirements of the following tile installation standards:
 - 1. For ceramic tile grouts comply with ANSI A108.10.

3.04 FLOOR TILE INSTALLATION

- A. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCA installation methods and ANSI A108 Series of tile installation standards.
 - 1. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
- B. Joint Widths: Install tile on floors with the following joint widths:
 - 1. Floor Tile: 1/4 inch.
- C. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.
- D. Grout Sealer: Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.05 WALL TILE INSTALLATION

- A. Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.
- B. Joint Widths: Install tile on walls with the following joint widths:
 - 1. Wall Tile: 1/4 inch.

3.06 CLEANING AND PROTECTING

- A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

- B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.07 FLOOR TILE INSTALLATION SCHEDULE

- A. Tile Installation: Interior floor installation over slab-on-grade concrete; thin-set mortar; TCA F113 and ANSI A108.5.
 - 1. Tile Type: Porcelain paver tile. [Glazed quarry]
 - 2. Thin-Set Mortar: Modified dry-set portland cement mortar.
 - 3. Grout: Polymer-modified sanded grout.
- B. Tile Installation: Interior floor installation over elevated-slab concrete; thin-set mortar; TCA F113A and ANSI A108.5.
 - 1. Tile Type: Porcelain paver tile. [Glazed quarry]
 - 2. Thin-Set Mortar: Modified dry-set portland cement mortar.
 - 3. Grout: Polymer-modified sanded grout.

3.08 WALL TILE INSTALLATION SCHEDULE

- A. Tile Installation: Interior wall installation over gypsum board; thin-set mortar; TCA W243 and ANSI A108.5.
 - 1. Tile Type: Porcelain ceramic wall tile.
 - 2. Thin-Set Mortar: ANSI 118.4, modified dry-set portland cement mortar.
 - 3. Grout: Polymer-modified sanded grout.
- B. Tile Installation: Interior wall installation over gypsum board; thin-set mortar; TCA W243 and ANSI A108.5.
 - 1. Tile Type: Large-format porcelain ceramic wall tile.
 - 2. Thin-Set Mortar: ANSI 118.15, improved modified dry-set portland cement mortar.
 - 3. Grout: Polymer-modified sanded grout.
- C. Tile Installation: Interior wall installation over glass-mat, water-resistant backer board; thin-set mortar ; TCA W247 and ANSI A108.5.
 - 1. Tile Type: Porcelain ceramic wall tile.
 - 2. Thin-Set Mortar: ANSI 118.4, modified dry-set portland cement mortar.
 - 3. Grout: Polymer-modified sanded grout.

3.09 MOVEMENT JOINT INSTALLATION SCHEDULE

- A. Concrete Control Joint: Interior floor installation over slab-on-grade concrete; thin-set mortar; TCA F113 and ASTM C1193.
 - 1. Tile Type: Porcelain paver tile.
 - 2. Thin-Set Mortar: Modified dry-set portland cement mortar.
 - 3. Slab Joint Type: Cold-joint or saw-cut.
 - 4. Floor joint: Saw-cut tile; TCA EJ171; polyurethane sealant, 1/2" wide.
- B. Concrete Control Joint: Interior floor installation over elevated-slab concrete; thin-set mortar; TCA F113A and ASTM C1193.
 - 1. Tile Type: Porcelain paver tile.
 - 2. Thin-Set Mortar: Modified dry-set portland cement mortar.
 - 3. Slab Joint Type: Cold-joint or saw-cut.
 - 4. Floor joint: Saw-cut tile; TCA EJ171; polyurethane sealant, 1/2" wide.

END OF SECTION

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SECTION 09 65 13

RUBBER BASE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Resilient wall base.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: 12-inch long samples of each type of base and color.
- C. Maintenance Data: For resilient products to include in maintenance manuals.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact.
- B. Store liquid emulsions and adhesives in unopened containers and protected from freezing.

PART 2 - PRODUCTS

2.01 RESILIENT WALL BASE

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to:
 - 1. Armstrong World Industries, Inc.; Rubber Base.
 - 2. Burke Flooring Products; BurkeBase TP.
 - 3. Roppe Corporation; TPR 700 Series.
 - 4. Johnsonite – Tarkett; Duracove.
- B. Wall Base: ASTM F 1861.
 - 1. Material: Type TP, integral-color thermoplastic rubber.
 - 2. Style: Cove Top-set [at carpet]
 - 3. Minimum Thickness: 0.125 inch
 - 4. Height: 4 inches
 - 5. Lengths: Coils in manufacturer's standard length
 - 6. Corners: Premolded, smooth surface.
 - 7. Colors: Manufacturer's standard color range.

2.02 RESILIENT MOLDING ACCESSORY

- A. Description: Carpet edge transition for glue-down applications.
 - 1. Burke Mercer Flooring Products; No. 150.
 - 2. Roppe Corporation; No. 25.

2.03 INSTALLATION MATERIALS

- A. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.
 - 1. Verify that finishes of substrates comply with tolerances and are free of cracks, ridges, depressions and foreign objects that might interfere with adhesion of resilient base.
 - 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.

3.03 RESILIENT WALL BASE INSTALLATION

- A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- D. Do not stretch wall base during installation.
- E. Premolded Corners: Install premolded corners before installing straight pieces.

3.04 RESILIENT ACCESSORY INSTALLATION

- A. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor coverings that would otherwise be exposed.

3.05 CLEANING AND PROTECTION

- A. Perform the following operations immediately after completing resilient product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Damp-sponge surfaces to remove marks and soil.
- B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.

END OF SECTION

SECTION 09 65 19

RESILIENT TILE FLOORING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Vinyl tile for glued applications.
- B. Related Sections include the following:
 - 1. Section 09 65 13 for "Rubber Base" for resilient wall base types.

1.02 PERFORMANCE REQUIREMENTS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM F 150 – Electrical Resistance of Flooring between 10.6 and 10.9 ohms.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: Full-size units of each type and composition of tile and color.

1.04 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. Floor Tile: Furnish 5 boxes for each type, color, and pattern of floor tile installed.

PART 2 - PRODUCTS

2.01 VINYL TILE

- A. Available Products: As scheduled on Drawings.

2.02 ACCESSORIES

- A. Resilient Wall Base: Refer to Section 09 65 13 – "Rubber Base".
- B. Carpet Edge: Carpet edge transition for glue-down applications.
 - 1. Burke Mercer Flooring Products; No. 152.
 - 2. Roppe Corporation; No. 25
- C. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic cement based formulation provided or approved by resilient product manufacturer for applications indicated.
- D. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. VCT Adhesives: Not more than 50 g/L.
 - b. Rubber Floor Adhesives: Not more than 60 g/L.
- E. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.
- F. Grounding Strips: Copper strips as recommended by SDT tile manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.
 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
 2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
 3. Moisture Testing:
 - a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
- C. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
- D. Use trowelable leveling and patching compound to fill cracks, holes, and depressions in substrates.
- E. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- F. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 TILE INSTALLATION

- A. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 1. Lay tiles square with room axis.

- B. Match tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain running in one direction.
- C. Scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings. Extend tiles into toe spaces, door reveals, closets, and similar openings.
- D. Maintain reference marks, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates.
- E. Install tiles on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern with pieces of tile installed on covers. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- F. Adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, telegraphing of adhesive spreader marks, and other surface imperfections.
 - 1. Adhere SDT tiles with manufacturer's proprietary SDT adhesive and installation methods.

3.04 RESILIENT WALL BASE INSTALLATION

- A. Apply wall base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- B. Install wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.
- C. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- D. Do not stretch wall base during installation.
- E. On masonry surfaces or other similar irregular substrates, fill voids along top edge of wall base with manufacturer's recommended adhesive filler material.
- F. Premolded Corners: Install premolded corners before installing straight pieces.

3.05 RESILIENT ACCESSORY INSTALLATION

- A. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor coverings that would otherwise be exposed.

3.06 CLEANING AND PROTECTION

- A. Perform the following operations immediately after completing resilient product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
 - a. Do not wash surfaces until after time period recommended by manufacturer.
- B. Protect resilient products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.
 - 1. Apply protective floor polish to horizontal surfaces that are free from soil, visible adhesive, and surface blemishes if recommended in writing by manufacturer.
 - a. Use commercially available product acceptable to manufacturer.

- b. Coordinate selection of floor polish with Owner's maintenance service.
- 2. Cover products installed on horizontal surfaces with undyed, untreated building paper until Substantial Completion.
- 3. Do not move heavy and sharp objects directly over surfaces. Place hardboard or plywood panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION

SECTION 09 68 13

CARPET TILE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes furnishing and installation of modular carpeting, base, and all accessories necessary for a complete installation, including the following for:
 - 1. Modular carpet tile as indicated on Drawings or as scheduled herein.

1.02 REFERENCES

- A. Carpet and Rug Institute (CRI):
 - 1. CRI 104 – Standard for Installation of Commercial Carpet.

1.01 PERFORMANCE REQUIREMENTS

- A. Slabs-on-Grade: Interior floor slabs to receive applied floor finishes shall be tested as specified herein for calcium chloride content and moisture vapor transmission. Vapor transmission must be less than 3 pounds per 1,000 square feet per 24 hours, prior to placement of flooring finishes.

1.03 SUBMITTALS

- A. Submittals:
 - 1. Product Data: Submit for flooring products and adhesives indicating testing and product requirements complying with SCAQMD or Carpet and Rug Institute's Green Label Plus program, as applicable.
 - 2. Installation Methods: Submit manufacturer's installation instructions for each type of carpeting material and installation accessories required. Include minimum slab-moisture levels required before carpet installation can be proceed.
- B. Shop Drawings: Submit shop drawings showing carpet layout and seaming diagrams (if applicable), clearly indicating carpet direction, pattern orientation, and types of edge strips. Indicate columns, doorways, enclosing walls/partitions, built-in cabinets, and locations where cutouts are required in carpet.
- C. Test Reports: Submit the following certified test reports, as applicable:
 - 1. Smoke Density Test: NFPA 258 or ASTM-E-662, less than 450.
 - 2. Flame Resistance: ASTM-D-2859, self-extinguishing for tile, ASTM-E 648 for glue-down.
 - 3. Dimensional Stability: Aachen Test DIN-STD-54318, for both wet and dry conditions.
- D. Samples for Verification Purposes: Submit the following samples prepared from same material to be used for the work:
 - 1. Three tiles of each pattern and color.
- E. Maintenance Instructions: Submit manufacturer's printed instructions for maintenance of installed work, including methods and frequency recommended by both carpet and fiber manufacturers for maintaining optimum condition under anticipated traffic and use conditions. Include precautions against materials and methods which may be detrimental to finishes, color fastness and performance.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firm (carpet manufacturer) with not less than 5 years of production experience with modular carpet systems.
- B. Installer Qualifications: Firm specializing in carpet system installations with not less than 5 years of experience in installation of glue-down modular carpet systems and roll-goods applications. Installer shall be approved by manufacturer of carpet products.
- C. Single Source Responsibility: Provide wear-surface and backing materials from a single manufacturer for each carpet type.
- D. Certification: Submit manufacturer's certification stating that material complies with or exceeds test reports and specified requirements herein.

1.05 PROJECT CONDITIONS

- A. Field Measurements: Verify installation dimensions and seaming layouts by making field measurements.
- B. Moisture Content: Verify acceptable moisture content of floor slabs prior to installation.

1.06 SEQUENCING AND SCHEDULING

- A. Installation: Sequence carpet installation with other work to minimize possibility of damage and soiling during remainder of construction period.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with instructions and recommendations of manufacturer for special delivery, storage, and handling requirements.

1.08 WARRANTY

- A. Special Warranty: Written warranty, signed by applicator and manufacturer (Mill) agreeing to repair or replace defective materials and workmanship during warranty period, including but not limited to:
 - 1. Delamination of glue-down carpet from floor substrate, or carpet from backing.
 - 2. Edge raveling, snags or runs.
 - 3. Trim accessories detachment to floor.
- B. Warranty Period: Five years from date of acceptance of installation.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Modular Carpet Tile (CP1):
 - 1. Manufacturer: Queen.
 - 2. Style: Change in Attitude
 - 3. Size: 24" x 24"
 - 4. Color: 12205 Lighten Up
 - 5. Pattern: See Drawings.

2.02 ACCESSORIES

- A. Vinyl Base: Refer to Section 09 65 13 – "Rubber Base".

- B. Carpet Edge Guard, Non-metallic: Extruded or molded heavy-duty vinyl or rubber carpet edge guard; minimum 2" wide anchorage flange; colors selected from manufacturer's standard colors.
- C. Releasable Carpet Adhesive: Water-resistant, solvent-free, non-staining as recommended by carpet manufacturer, which complies with flammability requirements for installed carpet and allows for removal of carpet tile without damage to carpet or substrate.
- D. Miscellaneous Materials: As recommended by manufacturers of carpet, cushions, and other carpeting products; selected by Installer to meet project circumstances and requirements.
- E. Self-leveling Underlayment: Pourable-grade, acrylic-modified, self-leveling cementitious compound. Acceptable products include:
 - 1. Vitex PFU; Parabond.
 - 2. Henry 555 LevelPro; ARDEX Americas.
 - 3. LevelLite; Custom Building Products.
 - 4. ProSpec Level Set 100 H.B. Fuller Construction Products.
- F. Patching Mortar: Dry-pack mix consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing No. 16 sieve, using only enough water for placing. Acceptable products include:
 - 1. Vitex M-600; Parabond.
 - 2. SN234; Henry Company.
 - 3. SpeedFinish; Custom Building Products.
 - 4. ProSpec Floor Patch Pro; H.B. Fuller Construction Products.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine substrates for moisture content and other conditions under which carpeting is to be installed. Notify contractor in writing of major conditions detrimental to proper completion of the work. Do not proceed until unsatisfactory conditions have been corrected.
 - 1. Test concrete for excessive moisture content or hydro-static moisture content. Excessive moisture is defined as exceeding 3 pounds of water per 1000 square feet of floor area.
 - 2. Test concrete for excessive acidity/alkalinity which shall test in the 6.0 and 8.0 range.

3.02 PREPARATION

- A. Preparation of Concrete Floors: Comply with CRI 104, Section 8.0, "Substrate Preparation," and carpet tile manufacturer's requirements. Clean concrete surfaces of drywall compounds, oil, paint, curing agents or sealers. After cleaning floors, sweep and vacuum floors of residual dust and debris. Do not use oil-based sweeping compounds.
- B. Surface Level Finish: Fill floor depressions with self-leveling underlayment. Fill all minor holes, cracks, indentations with patching compound. All protrusions should be sanded or ground level.
- C. Do not begin carpet tile installation until interior building temperatures and humidity has acclimated and all permanent mill-work, fixtures and built-in equipment have been installed.

3.03 MODULAR TILE INSTALLATION

- A. General: Comply with CRI 104, Section 10, "Carpet Tile" and with manufacturer's recommendations for direction of carpet pattern; maintain uniformity of carpet location and layout of pattern(s) in conformance with approved shop drawings.
 - 1. Center tile layout in each room unless otherwise indicated.
 - 2. Apply release-type adhesive uniformly to concrete substrates with notched-trowel in accordance with manufacturer's instructions.

3. Fit tile seams tightly but not compressed and uniformly straight such that seams are not visible from a distance of 10 feet.
4. Run tile pattern in a uniform direction, unless otherwise indicated on approved shop drawings.
5. For pre-applied peel-and-stick adhesive systems, pressure-roll tile in place to ensure adequate bond of tile to floor.
6. Install carpet edge guard where edge of carpet is exposed; anchor guards to floor substrate.

3.04 FIELD QUALITY CONTROL

- A. Calcium chloride test requirements: Before installation of carpet flooring over the interior concrete slabs, provide calcium chloride test to determine the level of water vapor transmission in the slab.
 1. Conduct testing in accordance with ASTM F1869 or ASTM E1907 (quantitative anhydrous calcium chloride test).
 2. Conduct calcium chloride tests after HVAC system has been in continuous use for 36 hours with a minimum ambient temperature of 72 degrees F. Readings conducted without a sustained ambient temperature is not acceptable.
 3. Document test results and provide copy to Architect with a floor finish plan showing areas of test results.
 4. Provide a written clarification on status of HVAC system before and during the test and the length of time the ambient air temperature was maintained before the tests.

3.05 CLEANING

- A. Remove and dispose of debris and unusable scraps. Vacuum carpet using commercial machine with face-beater element. Remove spots or stains and replace carpet where they cannot be removed. Remove any protruding face yarn using sharp scissors.

3.06 PROTECTION

- A. Provide protective methods and materials needed to ensure that carpeting will be without deterioration or damage at time of substantial completion.

END OF SECTION

SECTION 09 77 23

FRP PANELING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes fiberglass-reinforced plastic wall covering panels.

1.02 SUBMITTALS

- A. Product Data: Manufacturer's Specifications and installation instructions for each material and accessory.
- B. Submit Manufacturer's full range of color and pattern samples of wall panels and trim pieces for Architect's selection. Submit two samples of selected products.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer with a minimum of 3 years documented experience with wall panel installations similar in material, design, and extent to that indicated for this Project.
- B. Codes and Standards: Comply with applicable provisions of the following codes, specifications and standards, unless more stringent provisions are indicated or specified:
 - 1. ASTM D 5319, "Standard Specification for Glass-Fiber Reinforced Polyester Wall and Ceiling Panels."

1.04 DELIVERY, AND STORAGE

- A. Deliver materials to project site in original factory packages or containers, clearly labeled to identify manufacturer, brand name, lot number, quality or grade, and fire hazard classification.
- B. Store materials inside in original undamaged packaging, in a well-ventilated area protected from weather, moisture, soiling, extreme temperatures and humidity. Do not store panels upright; lay flat, blocked off the ground to prevent sagging and warping. Maintain temperature in storage area above 40 deg F.

1.05 WARRANTY

- A. Special Warranty: Written warranty, signed by applicator and manufacturer agreeing to repair or replace defective materials and workmanship during warranty period, including but not limited to:
 - 1. Delamination from wall substrate or backing.
- B. Warranty Period: One year from date of acceptance of installation.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Furnish products of one of the specified Manufacturers, subject to compliance with Specification requirements.
 - 1. Glasbord; Crane Composites, Inc.
 - 2. Standard FRP; Marlite Company.
 - 3. FiberLite FRP; Nudo Products Inc.
- B. Panels and Accessories:
 - 1. Panels: Class III (C) Interior Finish.
 - a. Color: to be as selected by Architect.
 - b. Panel Thickness: nominal 0.075 inch.
 - c. Panel Finish: Embossed.
 - d. Panel Edge Molding: to be 2 piece batten type with snap-on trim.
 - e. Concealed Fasteners: to be Manufacturer's standard nylon drive pins.
- C. Adhesive: Manufacturer's recommended type for use with selected materials, waterproof, mildew resistant type.
- D. Caulking: Silicone type as approved by Adhesive and Wall Paneling Manufacturer.
- E. Moldings: Extruded anodized aluminum trim pieces. Use at internal and external corners.
- F. Primer Sealer: Provide sealer or undercoat for new gypsum wallboard substrates as recommended by panel manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
 - 1. Examine substrate and conditions under which the material is to be installed. Verify that surfaces, when tested with moisture meter, have proper moisture content.
 - 2. Verify that wall fasteners are recessed, with joints and depressions taped and finished.
 - 3. Do not proceed with Work until Work of other Trades which penetrates wall panels have been completed and unsatisfactory conditions have been corrected.
 - 4. Start of Work indicates acceptance of responsibility for performance and any required remedial Work.

3.02 INSTALLATION

- A. Install panels in accordance with Manufacturer's printed instructions using full sheet mastic coverage method plus nylon fasteners.
- B. Make panel joints with 1/8 inch space for expansion and use mouldings designed for each condition for the Project.
- C. Bevel back edges of panels with block plane to permit proper fit into mouldings.
- D. If one end of panel must be fastened, do not fasten opposite end to allow panel movement.
- E. Remove plumbing escutcheons, switchplates, wall plates, and surface-mounted fixtures, and cut wall paneling evenly to fit. Replace items after completion of Work.

3.03 CLEANING AND PROTECTION

- A. Remove excess adhesive and smudges with soft cloth and mineral spirits.

- B. Provide protective methods and materials needed to ensure that panels will be without deterioration or damage at time of substantial completion.

END OF SECTION

SECTION 09 91 16

PAINTING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes surface preparation and field painting of exterior items and surfaces and interior painting, including the following:
 - 1. Canopy and trellis steel.
 - 2. Site-cast tilt-panel concrete walls.
 - 3. Site wall masonry.
 - 4. Back side of roof parapets.
 - 5. Exterior gypsum board soffits.
 - 6. Exterior gates and hardware.
 - 7. Galvanized sheet metal and perforated steel plate or decking.
 - 8. Interior or exterior steel stairs and railings.
 - 9. Interior concrete tilt-panel walls.
 - 10. Interior steel columns.
 - 11. Interior steel structural framing, joists and metal deck.
 - 12. Hollow metal doors and frames.
 - 13. Misc. steel for bollards, hand-railings, rough hardware and similar exterior items.
 - 14. Electrical panels and service entrance equipment, wall-mounted landscape controllers, water piping, back-flow device piping, equipment covers and similar above-grade utility items.
 - 15. Concrete floor sealer.
- B. Related Sections include the following:
 - 1. Section 03 30 00 for "Cast-in-Place Concrete" for concrete floor sealer application.
 - 2. Section 05 12 00 for "Structural Steel" for shop priming structural steel.
 - 3. Section 05 31 13 for "Steel Joists" for shop priming of metal joists
 - 4. Section 05 50 00 for "Metal Fabrications" for shop priming and field painting of ferrous metals.
 - 5. Section 05 51 10 for "Steel Stairs" for shop priming and field painting metal stair components.
 - 6. Section 32 17 23 for "Traffic Marking Paint" for traffic-marking paint in paved areas.
- C. Paint exposed surfaces, except where a surface or material is specifically indicated not to be painted or is to remain a natural finish. If an item or a surface is not specifically mentioned, paint the item or surface the same as similar adjacent materials or surfaces.
 - 1. Interior painting includes field painting of:
 - a. Drywall partitions and ceilings;
 - b. Exposed pipes, miscellaneous steel supports and embeds;
 - c. Surfaces of mechanical and electrical equipment that do not have a factory-applied final finish coat;
 - d. Exposed ductwork and electrical conduits;
 - e. Exposed masonry partitions that are not integrally colored;
 - f. Exposed metal deck and steel supports, only to the extent where specifically indicated on the Drawings.
 - 2. Exterior painting includes field painting of:
 - a. Electrical service entrance equipment cabinets;
 - b. Landscape controllers and conduit;
 - c. Light pole fixture concrete pole bases;
 - d. Mechanical equipment room wall louvers;
 - e. Traffic control sign posts;
 - f. Fire lane curbing.
- D. Painting is not required on factory-prefinished interior items, surfaces concealed from view, finished metal surfaces, operating parts, and labels. Prime coats are not considered prefinished coats.
 - 1. Prefinished items include the following:

- a. Architectural millwork, casework and paneling.
 - b. Acoustical ceiling tile or wall panels.
 - c. Mechanical system components, including air-diffusers and grills.
 - d. Interior electrical equipment, panels, light fixtures.
 - e. Anodized, powder-coated or PVDF coated metal.
 - f. Polished, plated or stainless steel surfaces.
2. Labels: Do not paint over UL, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.02 DEFINITIONS

- A. Gloss and Sheen: Standard coating terms defined in ASTM D 523 apply to this Section.
 1. Flat: matte finish with a maximum gloss below 5 units.
 2. Low Sheen: low-sheen finish with a maximum gloss below 10 units.
 3. Eggshell: low-sheen finish with a gloss range between 10 and 25 units.
 4. Satin: medium-sheen finish with a gloss range between 20 and 35 units.
 5. Semi-gloss: medium-sheen finish with a gloss range between 35 and 70 units.
 6. Gloss: high-sheen finish with a gloss range between 70 and 85 units.

1.03 SUBMITTALS

- A. Product Data: For each paint system indicated. Include block fillers and primers.
 1. Material List: Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 2. VOC Content: For all products or components applied to the interior of the building. Include certifications of VOC compliance with local regulatory agencies, where applicable.
- B. Samples for Verification Purposes: Provide draw-down samples for each color, sheen and material to be applied, with texture to simulate actual conditions of substrates.

1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: A firm or individuals experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Standards: Preparation, application and workmanship shall be in accordance with manufacturer's recommendations and applicable provisions of the following:
 1. Painting and Decorating Contractors of America (PDCA) "Painting Specification Manual" and "Standards".
 2. Gypsum Association - GA210, "Gypsum Board for Walls and Ceilings."
- C. Source Limitations: Obtain thinners, fillers and primers from the same manufacturer as the finish coats.
- D. Exterior **Color Mock-up**: After approval of draw-down samples, provide a 20' x 20' test area on area designated by the Architect, of the approved colors at locations indicated on the Drawings. Contractor shall include the cost of color mock-up in the base bid, including the cost to repaint mock-up one additional time.
 1. Approval of mockups is for color, texture, and blending of coatings; include cost to apply a second alternative color application, should initial colors not be approved.
 2. Do not order paint materials until mock-ups have been approved.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name, product label and date of manufacturer.

- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 50 deg F. Maintain storage containers in a clean condition, free of foreign materials and dried residue. Protect from freezing. Remove oily rags and combustible waste daily.

1.06 PROJECT CONDITIONS

- A. Environmental Requirements: Apply paints only when surfaces are dry and temperatures of surfaces to be painted and surrounding air are between 50 and 100 deg F.
 - 1. Do not apply exterior paint in damp or rainy weather or until after the surface has dried thoroughly from the effects of such weather.
 - 2. Provide adequate ventilation for interior painting so humidity levels do not rise above the dew point of the surface to be painted.
 - 3. Moisture-containing surfaces, such as concrete, stucco and cement plaster shall have a moisture content of less than 8 percent as measured by moisture meter. Remove surface salt deposits prior to painting. Verify that pH is within acceptable limits of Paint Manufacturer.

1.07 EXTRA MATERIALS

- A. Furnish extra paint materials, packaged with identifying labels describing contents, and deliver to Owner.
 - 1. Quantity: Furnish Owner with extra paint materials of 5 gal. of each color and gloss.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Dunn-Edwards (DE)
 - 2. PPG Architectural Coatings (PPG)
 - 3. Sherwin-Williams Co. (SW)

2.02 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Materials selected for coating systems for each type of surface shall be the products of a single manufacturer. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- C. Regulation Compliance: Materials used shall comply with applicable Federal and local air pollution regulations, lead content laws, and current VOC requirements. If products listed herein are not in compliance with regulations, laws, or requirements, Contractor shall notify Architect and shall provide information regarding substitute products that are in compliance with current VOC requirements.
- D. Supplementary materials such as thinners, linseed oil, shellac, turpentine, driers, and other similar products, shall be of highest quality, made by reputable, recognized manufacturers, and have identifying labels on containers. Paint materials shall be factory mixed except for field catalyzed coatings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions under which painting will be performed for compliance with application requirements. Do not begin paint application until unsatisfactory conditions have been corrected.
 - 1. Start of painting will be construed as Applicator's acceptance of substrate surfaces and conditions.
 - 2. Surfaces receiving coatings or fillers must be thoroughly dry and less than maximum moisture content acceptable to paint coating manufacture. Before paint application, verify that moisture content of surfaces, measured with an electronic moisture meter, are less than the following values:
 - a. Gypsum Board and Concrete: 10 percent.
 - b. Wood: 15 percent.
- B. Coordination of Work: Review other Sections in which materials or components are pre-finished or factory-primed to ensure compatibility of the paint system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

3.02 PROTECTION

- A. Before painting, remove hardware, accessories, electrical plates, lighting fixtures and similar items and protect. On completion of each area, replace above items.
 - 1. Provide barricades and coverings as required to protect work of other trades.
 - 2. Protect plants, glass, window framing and other exterior finished surfaces from contact with cleaning materials and thoroughly flush with water after contact.
 - 3. Mask permanent labels and adjacent surfaces from paint application.

3.03 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide masking and covered protection before surface preparation and painting.
 - 1. Clean surfaces of dust, rust, stains, scale, mildew, grease, oil, deteriorated substrates, bond-breakers, efflorescence and other foreign matter detrimental to the coating's adhesion and performance. Repair voids, cracks, nicks, and other surface defects, with appropriate patching material. Finish flush with surrounding surfaces and match adjacent finish texture.
 - 2. Spot prime marred or damaged shop coats on metal surfaces with appropriate metal primer.
 - 3. Provide barrier coats over incompatible primers or remove and reprime with compatible primer.
- B. Concrete and Stucco:
 - 1. Determine alkalinity content of cementitious surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if alkalinity exceeds that permitted in manufacturer's literature. Surfaces requiring painting or finishing shall be thoroughly dry and cured.
 - 2. Remove curing, bond-breaker or form-release agents from surfaces to be painted.
 - 3. Repair surfaces to be painted prior to application of prime and finish coat(s). Repair surface imperfections to match and flush-out with adjacent finish texture and profile. Apply primer to repaired surfaces after patch or fill material has thoroughly dried.
 - 4. Spot prime exposed metal embeds and plates occurring in the surfaces with a rust inhibitive primer as recommended by paint manufacturer.
- C. Ferrous Metals:
 - 1. Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove grease, oil, mill scale, rust and rust scale and touch-up chipped or abraded places on items that have been shop coated. Remove and reprime incompatible or damaged shop applied primers. Comply with the Steel Structures Painting Council's (SSPC-SP2) recommendations for cleaning of uncoated steel surfaces.

2. When area will be exposed to view, sand the entire primed area smooth, feather the edge of surrounding undamaged prime coat and spot prime in a manner to eliminate evidence of repair.
 3. Mechanically abrade and wire-brush weld slag from field welds. Grind welds smooth and spot prime.
- D. Galvanized Metal and Aluminum:
1. Thoroughly clean by wiping surfaces with a non-solvent cleaner that will not leave an oily residue. Apply surface conditioner or vinyl-wash pretreatment as required for proper adhesion if required by paint manufacturer. Prime galvanized metal with galvanized metal primer as recommended by paint top-coating manufacturer.
 2. Remove roller oil from galvanized coil-stock fabricated metal deck products with suitable cleaner.
 3. Clean visible portions of interior throats of galvanized steel ductwork and paint flat black.
- E. Gypsum Board Surfaces:
1. Fill cracks, holes or imperfections in with compatible patching material and smooth off to match adjoining surfaces.
 2. Before painting, surfaces shall be tested for dryness with a moisture testing device. Do not apply paint or sealer on gypsum board when the moisture content exceeds 10 percent.

3.04 APPLICATION

- A. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and dried residue.
 2. Stir material before application to produce a mixture of uniform density and color. Do not stir partially dried paint or surface film into material.
 3. Use only thinners approved by paint manufacturer and only within recommended limits.
- B. General: Apply paint according to manufacturer's written instructions. Use application techniques best suited for substrate and type of material being applied.
1. Paint coatings, surface treatments, and finishes are indicated in the paint schedules.
 2. Provide finish coats that are compatible with primers used.
 3. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture.
 4. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
- C. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. Sand between applications to produce a smooth, even surface.
 2. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 3. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried and until application of another coat of paint does not cause under-lying coat to lift or lose adhesion.
- D. Workmanship
1. Apply each coat of paint evenly and comply with manufacturer's drying time before applying subsequent coats.
 2. Finished work shall be uniform, match approved color, texture and coverage, and free from runs, sags, clogging or excessive flooding. Make edges of paint adjoining other materials or colors sharp and clean, without overlapping. Where varnishes or enamel is used, lightly sand, dust and clean undercoats to obtain a smooth finish coat. Sand carefully between each coat of finish on smooth surfaces for good adhesion of subsequent coats.
 3. Where clear finishes are required, ensure tinted fillers match wood. Work fillers sufficiently into the wood grain before drying. Wipe excess from the surface and sand smooth when dried.

- E. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve a minimum dry film thickness of **1.6 mils** (DFT) per coat, unless thicker coating applications are indicated in Paint Schedules.
- F. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished. Recoat primed and sealed surfaces where evidence of blushing or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects.
- G. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled. Provide level of block fill as scheduled to conform with the following:
 - 1. Level 1 – Medium Full Fill: One coat, spray applied and back-rolled.
 - 2. Level 2 – Full Fill: Minimum block fill required for semi-gloss and gloss finishes. Provide number of coats as required to fill masonry pores and mortar pin-holes, spray applied and back-rolled.
- H. Exterior Steel: Paint exterior structural steel, steel supports, fabrications, embeds, weld plates, perforated metal-plates, railings and other similar metal items.
- I. Exterior Plumbing, Mechanical and Electrical: Items to be painted include, but are not limited to the following:
 - 1. Exposed water, gas, vent piping, pipe hangers or wall brackets, tanks, backflow preventers, conduit, lighting and electrical panels, telephone terminal boxes, galvanized ducts or exhaust hoods shall be painted to match adjacent wall colors.
- J. Interior Plumbing, Mechanical and Electrical: Items to be painted include, but are not limited to the following:
 - 1. Spray paint prime coated grilles and registers (not pre-finished) with enamel or lacquer to match walls and ceilings.
 - 2. Throats of ducts shall be given one coat of flat black paint, wherever visibility of the interior of the duct is allowed through registers or other similar items. At fiber lined duct, use black latex paint.
 - 3. Do not paint galvanized interior items, including ductwork, piping or conduit.
 - 4. Mechanical or electrical equipment on or adjacent to walls or surfaces scheduled for painting, shall be disconnected, using workmen skilled in appropriate trades, and moved temporarily to permit painting of surface. Following completion of painting, replace and reconnect items.
- K. Interior Miscellaneous Steel: Paint interior metal railings and handrails, ladders and ladder platforms. Paint interior metal structural items only where indicated.
- L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- M. Floor Sealers: Application of liquid sealer shall be performed by an approved applicator of the liquid sealer manufacturer.
 - 1. Floor Slab Cleaning: Prior to application of liquid sealer, inspect and thoroughly clean slab with auto scrubber to ensure that it is clean and free of salts, laitance, dust, grease, oils or other contaminants that might inhibit the proper application of the liquid sealer.
 - 2. Within twenty-four hours after air-dry period, spray-apply liquid sealer at a minimum coverage rate 200 sq. ft. per gallon in accordance with manufacturer's instructions.

3.05 CLEANING

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.
 - 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping without scratching or damaging adjacent finished surfaces.

3.06 PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.
- B. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.

3.07 COLOR FINISH SCHEDULES

- A. Color Schedule: Refer to the "Finish Schedule" on the Drawings for designated colors and finishes.
 - 1. Colors indicated may be from various manufacturer's color line. Manufacturers supplying paint shall match these colors and shall prepare and submit sets of samples for all colors and sheens for approval. If a specific surface or item receiving a paint finish does not have a specific color indicated or selected by the Architect, obtain clarification from the Architect.
- B. Finishing of the following listed items and materials will not be required and shall be protected:
 - 1. Finished products such as ceramic tile, glass, brick, flooring and acoustical tiles, and metal-tee grids.
 - 2. Pre-finished products such as wood folding partitions and doors, wood or plastic-laminate casework, and elevator cabs.
 - 3. Stainless Steel, brass, bronze, copper, chromium, anodized aluminum; specially finished fabrications such as synthetic-stone, and powder-coat enamel, unless otherwise indicated.

3.08 EXTERIOR PAINT SCHEDULE

- A. Concrete Unit Masonry: Apply to exterior concrete masonry unit construction indicated to be painted. Back-roll 2nd and 3rd coat. (Refer to Section 07 19 00 "Water Repellent Sealers" for concrete masonry units indicated to be stained or integral-color units to receive sealers.)
 - 1. Filler Coat: Masonry concrete block filler for exterior painted masonry application. Provide Level 1 Fill; DFT: 8.0 mils.
 - a. DE: SBSL00-1 Smooth Blocfil Select
 - b. PPG: 6-15XI Speedhide HI Fill Block Filler
 - c. S-W: B42W00150 Pro Industrial Block Filler
 - 2. 1st Coat: Alkali-resistant acrylic-latex concrete primer for exterior application. DFT: 3.0 mils.
 - a. DE: ESPR00 Eff-Stop Select
 - b. PPG: 4-603XI Perma-Crete Primer
 - c. S-W: LX02W0050 Luxon Primer
 - 3. 2nd and 3rd Coat: Flat, waterborne, 100% acrylic-emulsion latex paint for exterior application.
 - a. DE: SSSL10 Spartashield
 - b. PPG: 6-610XI Speedhide Exterior
 - c. S-W: A06W00151 A-100 Exterior
 - 4. 2nd and 3rd Coat: Satin, waterborne, 100% acrylic-emulsion latex paint for exterior application.
 - a. DE: SSSL40 Spartashield
 - b. PPG: 6-2045XI Speedhide Exterior
 - c. S-W: A82W00151 A-100 Exterior
- B. Site-cast Concrete: Apply to exterior cementitious surfaces as indicated. Precast concrete caps, sills, etc. shall not be painted, unless specifically noted. Back-roll 2nd coat.
 - 1. 1st Coat: Alkali-resistant acrylic-latex concrete primer for exterior application. DFT: 3.0 mils.
 - a. DE: ESLL00 Eff-Stop Select
 - b. PPG: 4-603XI Perma-Crete Primer
 - c. S-W: LX02W0050 Luxon Primer
 - 2. 2nd and 3rd Coat: Flat, waterborne, 100% acrylic-emulsion latex paint for exterior application.
 - a. DE: ACHS10 Acri-Hues
 - b. PPG: 6-610XI Speedhide Exterior
 - c. S-W: A06W00151 A-100 Exterior
- C. Ferrous Metal: Apply to exposed steel such as metal decking, beams, columns, connectors, metal doors and frames, grilles, light fixture standards in parking areas, metal handrails, sectional and coiling

doors, metal canopy overhangs and other exposed miscellaneous ferrous metals that are not pre-finished.

1. 1st Coat: Ferrous Metal Grey Primer. Rust-inhibitive, 100% alkyd metal primer for exterior application. DFT: 1.5 mils. Primer is required on shop-primed items.
 - a. DE: ENPR00 EnduraPrime Alykd Primer.
 - b. PPG: 17-941 Seal Grip Universal Alykd Primer.
 - c. S-W: B50AZ0008 Kem Bond HS Primer
 2. 2nd and 3rd Coat: Semi-gloss/satin, alkyd-enamel for exterior application. DFT: 4.0 mils total.
 - a. DE: ASHL50 Aristoshield Urethane Coating
 - b. PPG: 6-1410 Speedhide WB Alkyd Coating
 - c. S-W: B54W01151 Pro-Industrial Urethane Coating
 3. 2nd and 3rd Coat: Semi-gloss/satin, acrylic-enamel for exterior application. DFT: 4.0 mils total.
 - a. DE: EVSH50 Evergreen Acrylic Coating
 - b. PPG: 4216HP Pitt-Tech Acrylic Coating
 - c. S-W: B66W01151 Pro-Industrial Acrylic Coating
- D. Zinc-Coated Metal or Unfinished Aluminum: Apply to exposed mill-finish aluminum or galvanized metal such as parapet copings, louvers and metal flashings. Clean metal to remove foreign matter or any coating applied by the metal manufacturer. Apply Surface Conditioner or Vinyl Wash Pretreatment if required by paint manufacturer for proper bond.
1. 1st Coat: Metal Primer. Rust-inhibitive, 100% acrylic metal primer for exterior application. DFT: 2.0 mils. Primer is required on shop-primed items.
 - a. DE: BRPR00 Bloc-Rust Primer
 - b. PPG: 4020PF Pitt-Tech Plus Acrylic Primer.
 - c. S-W: B66W0011 Pro-Industrial DTM Acrylic Primer
 2. 2nd and 3rd Coat: Eggshell, acrylic-enamel for exterior application. DFT: 4.0 mils total.
 - a. DE: EVSH30 Evergreen Acrylic Coating
 - b. PPG: 90-474 Pitt-Tech DTM Acrylic Coating
 - c. S-W: B66W01251 Pro-Industrial DTM Acrylic Coating
 3. 2nd and 3rd Coat: Semi-gloss, acrylic-enamel for exterior application. DFT: 4.0 mils total.
 - a. DE: EVSH50 Evergreen Acrylic Coating
 - b. PPG: 4216HP Pitt-Tech Acrylic Coating
 - c. S-W: B66W01151 Pro-Industrial Acrylic Coating
- E. Exterior Gypsum Soffit Board: Apply to exposed exterior-grade gypsum board soffits where EIFS finish top-coats are not indicated:
1. 1st Coat: Acrylic-latex primer for exterior application.
 - a. DE: UGSL00-1 Ultra-Grip Select
 - b. PPG: 17-921XI Seal-Grip Universal Latex Primer
 - c. S-W: B51W00450 Multi-Purpose Latex Primer
 2. 2nd and 3rd Coat: Flat, waterborne, 100% acrylic-emulsion latex paint for exterior application.
 - a. DE: ACHS10 Acri-Hues
 - b. PPG: 6-610XI Speedhide Exterior
 - c. S-W: A06W00151 A-100 Exterior

3.09 INTERIOR PAINT SCHEDULE

- A. Interior Concrete Masonry: Apply to exposed interior concrete masonry units.
1. 1st Coat: Block Filler, w/o Aggregate. Provide Level 1 Fill; DFT: 8.0 mils.
 - a. DE: SBSL00-1 Bloc-Fil Select
 - b. PPG: 6-15XL Speedhide Block Filler
 - c. S-W: B42W00150 Pro Industrial HD Block Filler
 2. 2nd and 3rd Coat: Flat, waterborne, 100% acrylic-emulsion latex paint for exterior application.
 - a. DE: ACWL10 Acri-Wall
 - b. PPG: 6-70 Speedhide Interior
 - c. S-W: B30W12651 ProMar 200 Flat
- B. Concrete Substrates: Apply to interior tilt-up concrete wall surfaces as indicated.
1. 1st Coat: Alkali-resistant acrylic-latex concrete primer for interior application. DFT: 3.0 mils.
 - a. DE: ESSI00 Eff-Stop Select

- b. PPG: 17-921XI Seal Grip Universal Primer
 - c. S-W: LX02W0050 Luxon Primer
 - 2. 2nd and 3rd Coat: Low-Sheen, 100% acrylic-emulsion latex paint for interior application. DFT: 3.0 mils total thickness.
 - a. DE: Aqua30 Aquafall Dryfall Eggshell
 - b. PPG: 6-725XI Superhide Super Tech
 - c. S-W: B42W00182 Pro Industrial Dryfall Eggshell
- C. Metal Deck and Joists: Apply to exposed pre-primed metal decking, beams, joists and other exposed miscellaneous metals that are components of the floor or roof framing system.
 - 1. 1st Coat: Factory applied primer.
 - 2. 2nd and 3rd Coat: Semi-Gloss, alkyd-enamel. DFT: 3.0 mils total thickness.
 - a. BM: 105-1 Super Kote 5000 Alkyd Dryfall
 - b. PPG: 6-161XI Speedhide Alkyd Dry Fog
 - c. S-W: B47W00062 Super Save-Lite Alkyd Dryfall
- D. Non-structural Ferrous Metals: Apply to exposed metals such as steel roll-up doors, hollow metal doors and frames, stair railings, hand railings, ladders, and other exposed miscellaneous metals.
 - 1. 1st and 2nd Coat: Satin, acrylic-enamel. DFT: 4.0 mils total thickness.
 - a. DE: ASHL40 Aristoshield DTM
 - b. PPG: 90-1110 Pitt Tech Plus DTM
 - c. S-W: B66-1150 Pro Industrial DTM
- E. Ferrous Metals: Apply to exposed metals such as steel beams, columns, braces, steel wall embeds and plates, stair stringers, and other exposed structural steel items.
 - 1. 1st Coat: Ferrous Metal Grey Primer. Rust-inhibitive, acrylic metal primer for interior application. Primer is required on shop-primed items.
 - a. DE: BRPR00 Bloc-Rust
 - b. PPG: 17-921XI Seal Grip Universal
 - c. S-W: B66-310 Pro-Cryl
 - 2. 2nd and 3rd Coat: Satin, acrylic-enamel. DFT: 4.0 mils total thickness.
 - a. DE: SWLL40 Spartawall
 - b. PPG: 1406G Ultrahide 250
 - c. S-W: B66W00651 Pro Industrial
 - 3. 4th Coat: Semi-Gloss, acrylic-alkyd enamel, OSHA compliant safety yellow, applied for a distance of 12 feet above floor.
 - a. DE: Dura 50 Duraflo
 - b. PPG: 95-902C Fast Dry 35
 - c. S-W: SW4084 Kem 4000
- F. Galvanized Metals: Apply to exposed galvanized metal such as metal frames, ductwork, grilles and registers, stair and hand railings, ladders, and other exposed miscellaneous metals, where specifically indicated to be painted. Clean metal to remove foreign matter or any coating applied by the metal manufacturer. Apply Surface Conditioner or Pretreatment (if required by paint manufacturer).
 - 1. 1st Coat: Grey Metal Primer: Metal primer for interior application.
 - a. DE: ULGM00 Ultrashield
 - b. PPG: 17-921XI Seal Grip Universal
 - c. S-W: B66-310 Pro-Cryl
 - 2. 2nd and 3rd Coat: Satin, acrylic-enamel. DFT: 4.0 mils.
 - a. DE: SWLL40 Spartawall
 - b. PPG: 1402G Ultrahide 250
 - c. S-W: B66-660 Pro Industrial
- G. Gypsum Board: Apply to gypsum board walls, except for shower areas.
 - 1. 1st Coat: Waterborne low VOC Primer/Sealer.
 - a. DE: VNPR00 Vinylastic Premium
 - b. PPG: 6-4900XI Speedhide Zero Sealer
 - c. S-W: B28W02600 Pro-Mar 200 Zero Primer
 - 2. 2nd and 3rd Coat: eggshell, waterborne, 100% acrylic-emulsion low VOC latex paint.
 - a. DE: SWLL30 Spartawall.
 - b. PPG: 6-4310XI Speedhide

- c. S-W: B20W2651 Pro-Mar 200 Zero VOC
- H. Gypsum Board: Apply to gypsum board ceilings, except for shower areas.
 - 1. 1st Coat: Waterborne Primer/Sealer.
 - a. DE: VNPR00 Vinylastic Premium
 - b. PPG: 6-4900XI Speedhide Zero Sealer
 - c. S-W: B28W02600 Pro-Mar 200 Zero Primer
 - 2. 2nd and 3rd Coat: Flat, waterborne, 100% acrylic-emulsion low VOC latex paint.
 - a. DE: SWLL10 Spartawall.
 - b. PPG: 6-4110XI Speedhide
 - c. S-W: B30W12651 Pro-Mar 200 Zero VOC
- I. Concrete Floor Sealer: Apply to exposed concrete floors in stairs, electrical and telco equipment rooms. Application rate: 150 s.f. per gallon 1st coat; 250 s.f. per gallon 2nd coat.
 - 1. Two Coats: ASTM C 309, water-based acrylic, minimum 20% solids, low-gloss, clear.
 - a. Euclid EverClear WB
 - b. PPG Perma-Crete Plex-Seal WB
 - c. Sherwin-Williams H&C Clarishield

END OF SECTION

SECTION 10 14 00

TRAFFIC-CONTROL SIGNS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Site traffic control signs.

1.02 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for post and panel/pylon signage.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Provide graphic layout of text for each sign type.

1.03 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm experienced in designing and producing metal sign fabrications similar to those indicated for this Project.
- B. Regulatory Requirements: Comply with City of Colorado Springs regulatory requirements for sign locations and the following:
 - 1. 2010 ADA "Standards for Accessible Design".
 - 2. 2018 International Building Code, Chapter 11.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Metals: New stock, free from damage, scratches and warpage.
 - 1. Steel Shapes: ASTM A 36.
 - 2. Galvanized Steel Sheets: ASTM A 653, with G90 zinc coating.
 - 3. Steel Tubing: ASTM A 500.
 - 4. Aluminum Sheet: ASTM B 209, 0.080 inch minimum thickness.
- B. Paint: Non-fading, polyurethane enamel.

2.02 ACCESSORIES

- A. Bolts and Nuts: Provide nonferrous-metal or hot-dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance.

2.03 FABRICATION

- A. Graphics: Refer to Drawings for sign locations and specific text and graphic enumeration. Sign types include:
 - 1. Fire-Lane Control.
 - 2. ADA Accessible Parking.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing sign fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- C. Verify that items, including anchor inserts, are sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Excavation: Excavate hole depths for sign foundation approximately 24 inches below finished grade or as indicated. Reconstruct subgrade that is not firm, undisturbed, or compacted soil, or that is damaged by accumulated water, or construction activities by excavating a further 12 inches, backfilling with satisfactory soil, and compacting to original subgrade elevation.
- B. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.
 - 1. Install signs level, plumb, and at heights indicated, accurately fitted together with sign surfaces free of distortion and other defects in appearance.
 - 2. Mechanical Fasteners: Use nonremovable mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.

3.03 CLEANING AND PROTECTION

- A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.
- B. Touchup Painting: Immediately after installation, clean sign surfaces and repair any damaged graphics.

END OF SECTION

SECTION 10 21 13
TOILET PARTITIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes: Stainless steel clad toilet compartments and urinal screens as indicated on Drawings and include the following types:
 - 1. Compartment Type: Floor-anchored, overhead-rail braced.
 - 2. Screen Type: Wall hung.
- B. Related Sections include the following:
 - 1. Section 05 51 10 for "Metal Fabrications" for overhead steel support framing.

1.02 SUBMITTALS

- A. Shop Drawings: Submit installation drawings showing plans, elevations and details of construction. Indicate locations of concealed blocking and supports.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with local code and regulatory requirements for accessible design and the following:
 - 1. 2010 ADA "Standards for Accessible Design" and ADA Guidelines, as applicable.
 - 2. 2021 International Building Code, Chapter 11.

1.04 PROJECT CONDITIONS

- A. Field Measurements: Where partitions are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating partitions without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.
- B. Coordinate installation of blocking and anchorages for support of screens or partitions as required for complete installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Floor-Mounted Partitions: Furnish products of one of the following manufacturers subject to compliance with requirements herein:
 - 1. Floor Anchored/Overhead Braced; ASI Accurate Partitions.
 - 2. Luxor FT700; MetPar
 - 3. Floor Anchored/Overhead Braced; Sanyametal.
 - 4. Standard Series; Hadrian, Inc.
 - 5. Series 400; Bradley Corp.

2.02 MATERIALS

- A. Doors, stiles and compartment panels: 22 ga., Type 304 stainless steel clad, moisture resistant honeycomb core with finished panel thickness of 1 inch.
 - 1. Panel Height: 55-inches
 - 2. Pilaster Height: 82-inches
 - 3. Finish: No.4, brushed.
 - 4. Hardware and Brackets: Type 304 stainless steel, satin finish.
 - 5. Door Latch: Operated from inside of compartment.
 - 6. Floor Shoe: Vertically adjustable, Type 304 stainless steel, satin finish, to conceal floor anchor devices.
- B. Headrail: Aluminum alloy extrusion with satin finish and 18 gage stainless steel mounting brackets.
- C. Hinges: Type 304 stainless steel, satin finish, door hold-open cam to maintain doors partially open approximately 30 degrees.
- D. Urinal screens: Same construction and finish as compartment panels.
 - 1. Size: 58 x 24 inches deep.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and blocking where necessary for securing compartment panels and screens to in-place construction. Install partitions and supports to comply with requirements of manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Overhead Bracing: Fasten headrail to tops of pilasters and rail brackets with one-way sex bolts.
- C. Clearances:
 - 1. Maintain uniform clearance of 1 inch between panels or stiles and walls.
 - 2. Maintain uniform clearance of 12 inches between bottom of panels and floor.

3.02 ADJUSTING AND CLEANING

- A. Adjust door latch hardware and hinge hold-open feature for satisfactory operation.
- B. Protect partition finish from scratches and damage until accepted at time of Substantial Completion.

END OF SECTION

SECTION 10 28 13

TOILET ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes: Washroom accessories.

1.02 SUBMITTALS

- A. Product Data: Submit product literature of each item indicated, showing sizes and mounting locations.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with local code and regulatory requirements for accessible design and the following:
 - 1. 2010 ADA "Standards for Accessible Design".
 - 2. 2021 International Building Code, Chapter 11.

1.04 COORDINATION

- A. Coordinate installation of accessories with in-place construction. Furnish templates, and directions for installing anchorages, sleeves, inserts, anchor bolts, and related items. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 TOILET ACCESSORIES

- A. Basis-of-Design Product: The design for accessories is based on products indicated on Drawings. Except for grab bars, Owner will purchase accessories to be installed by Contractor.

2.02 MATERIALS

- A. Stainless Steel: AISI Type 302/304, with polished No. 4 finish, 22-gage (.034-inch) minimum thickness, unless otherwise indicated.
- B. Grab Bars: Cold-formed, 1 1/2 inch O.D., Type 304, stainless steel tubing with satin finish.
- C. Fasteners: Theft-proof screws.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing accessories to in-place construction.

3.02 INSTALLATION

- A. Install toilet accessories in accordance with manufacturers' instructions, using fasteners appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored in locations and at heights indicated.
- B. Wall Openings Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions.
- C. Secure mirrors to walls in concealed, tamperproof manner with special hangers, toggle bolts, or screws. Set units plumb, level, and square at locations indicated, in accordance with manufacturer's instructions for type of substrate involved.
- D. Grab Bars: Install blocking or anchor plates prior to wall finish installation. Upon completion of wall finish secure mounting plates using flush head stainless steel fasteners.
- E. Penetrations: Seal fixture penetrations, escutcheons and trim with silicone sealant to prevent moisture migration into walls and surrounding construction.

3.03 ADJUSTING AND CLEANING

- A. Adjust all devices for smooth operation. Clean prior to Substantial Completion.

3.04 TOILET ACCESSORIES SCHEDULE

- A. Basis-of-Design Product: See Drawings.
- B. Grab Bars:
 - 1. Basis-of-Design Product: Bobrick No. B-5806.
 - 2. Mounting: Flanges with concealed fasteners.
 - 3. Material and Finish: Stainless steel, 0.05 inch thick, smooth, No. 4, satin finish on ends and slip-resistant texture in grip area.
 - 4. Outside Diameter: 1-1/4 inches.
 - 5. Configuration and Length: 18", 24" and 42", as indicated on Drawings.

END OF SECTION

SECTION 10 44 16

FIRE EXTINGUISHERS AND CABINETS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Portable fire extinguishers and wall-brackets.
 - 2. Fire-protection cabinets for the following:
 - a. Portable fire extinguishers.

1.02 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection specialties.
 - 1. Fire Extinguishers: Include rating and classification.
 - 2. Cabinets: Include roughing-in dimensions, details showing mounting methods, door hardware, cabinet type, trim style, and panel style.

1.03 QUALITY ASSURANCE

- A. Standards: Comply with ANSI/UL 92 and 711.
- B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Standard for Portable Fire Extinguishers."
- C. Regulatory Requirements: Comply with local code and regulatory requirements for accessible design and the following:
 - 1. 2010 ADA "Standards for Accessible Design".
 - 2. 2021 International Building Code, Chapter 11.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Portable Fire Extinguishers and Cabinets:
 - a. FS SS O-2409; Larsen's Manufacturing Company.
 - b. FRC7260; Potter Roemer Fire Pro.
 - c. Embassy 5634; J.L. Industries, Inc.

2.02 MATERIALS

- A. Cold-Rolled Steel Sheet: Carbon steel, complying with ASTM A 366, commercial quality, stretcher leveled, temper rolled.
- B. Stainless-Steel Sheet: ASTM A 666, Type 302 or Type 304 alloy.

2.03 PORTABLE FIRE EXTINGUISHERS

- A. General: Provide fire extinguishers for each cabinet at locations indicated.
 - 1. Dry-Chemical Type: UL-rated Class A, 3A:40-B:C, 5-lb nominal capacity, in enameled-steel container.

2.04 FIRE-PROTECTION CABINETS

- A. Cabinet Construction: Provide manufacturer's standard box-shape, with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld joints and grind smooth. Miter and weld perimeter door frames.
 - 1. Fire-Rated Cabinets: Listed and labeled to meet requirements of ASTM E 814 for fire-resistance rating of wall where it is installed.
 - 2. Cabinet Metal: Enameled-steel sheet.
 - 3. Cabinet Type: Semi-recessed for cabinet box partially recessed in walls of shallow depth to suit style of trim indicated.
- B. Cabinet Trim Style: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.
 - 1. Exposed Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed square-edge trim face and wall return at outer edge (1-1/2-inch maximum backbend depth).
- C. Cabinet Door and Trim Material: Manufacturer's standard, as follows:
 - 1. Stainless-steel sheet.
 - a. Finish: No. 4 satin finish.
- D. Door Glazing: Manufacturer's standard, as follows:
 - a. Tempered Float Glass: 3 mm thick, clear, ASTM C 1048, Kind FT, Type I.
- E. Door Style: Manufacturer's standard design, as follows:
 - 1. Vertical duo panel with frame.
- F. Door Hardware: Provide manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated. Provide lever handle with cam-action latch. Provide concealed or continuous-type hinge permitting door to open 180 degrees.

2.05 ACCESSORIES

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure extinguisher, of sizes required for types and capacities of extinguishers indicated, with plated or baked-enamel finish.
 - 1. Provide standard J-brackets for extinguishers not located in cabinets.
- B. Door Locks: Provide non-keyed, cam-type latch.
- C. Identification: Provide lettering to comply with authorities having jurisdiction for letter style, color, size, spacing, and location.
 - 1. Identify fire extinguisher on cabinet door with the words "FIRE EXTINGUISHER".
 - a. Application Process: Silk-screened. Lettering Color: Black.

2.06 STAINLESS-STEEL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Remove or blend tool and die marks and stretch lines into finish. Grind and polish surfaces to produce uniform, directionally textured polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semi-recessed cabinets are to be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Comply with manufacturer's written instructions for installing fire-protection specialties.
- B. Install in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
 - 1. Prepare square and plumb recesses for cabinets as required by cabinet and trim style.
 - 2. Fasten mounting brackets to structure and cabinets, square and plumb.

3.03 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust cabinet doors that do not swing or operate freely.
- B. Refinish or replace cabinets and doors damaged during installation.
- C. Provide final protection and maintain conditions that ensure that cabinets and doors are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

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SECTION 10 51 13

METAL LOCKERS

PART 1 GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Wardrobe lockers, including the following:
 - a. Double tier.
 - 2. Locker benches.

1.02 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker and bench.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.
 - 1. Show locker fillers, trim, base, sloping tops, and accessories.
- C. Samples: Manufacturer's color charts showing the full range of colors available for units with factory-applied color finishes.
- D. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.03 QUALITY ASSURANCE

- A. Uniformity: Provide metal lockers that are standard products of single manufacturer, with interchangeable like parts. Include necessary mounting accessories, fittings, and fastenings.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver lockers until spaces to receive them are clean, dry, and ready for locker installation.
- B. Protect lockers from damage during delivery, handling, storage, and installation.

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. Vanguard; Penco Products, Inc.
 - 2. Emperor; Hadrian Manufacturing, Inc.
 - 3. Standard Metal Series; Lyon Metal Products, Inc.
 - 4. Standard Metal Series; Salsbury Industries.
 - 5. Standard Locker Series; Republic Storage Systems Co., Inc.
- B. Tier Units: Provide steel lockers with vented door panel as specified herein. Provide the following arrangements and sizes as indicated on the Drawings:

1. Locker Type 2: Double tier units; each locker 18 inches wide x 18 inches deep x 36 inches high.

2.02 MATERIALS

- A. Sheet Steel: ASTM A 366, cold-rolled and stretcher-leveled furniture steel, free from buckle, scale, and surface imperfections.

2.03 WARDROBE LOCKERS

- A. Body: Fabricate back and sides of minimum 24 gage steel, with double flanged connections extending full height. Form top and bottom of not less than 24 gage steel, with flanged edges.
 1. Provide 24 gage, steel sheet hat shelf in single tier units.
 2. Form exposed ends of non recessed lockers of minimum 16 gage steel.
- B. Door: One piece, minimum 16 gauge sheet steel, flanged at all edges, constructed to prevent springing when opening or closing. Fabricate to swing 180 degrees.
 1. Ventilation: Provide stamped, louvered vents in door face.
 2. Hinges: Steel, full loop, 5 knuckle, tight pin. Weld to inside of frame and secure to door with not fewer than 2 fasteners that are completely concealed and tamperproof when door is closed.
- C. Handle and Latch: Positive automatic, non-protruding, prelocking, pry resistant latch and pull; 14 gage plastic covered, heavy duty, vandal-proof lift-up handle, with strike and eye for padlock.
 1. A 20 gauge stainless steel recessed pocket containing the latch and handle shall be provided.
- D. Acoustical Treatment: Provide construction treatment designed for significant reduction of noise of locker operation, including protected sound absorbing material; nylon or plastic coatings on operating components to prevent metal to metal contact, and latching mechanism designed to operate without rattling.

2.04 LOCKER ACCESSORIES

- A. Equipment: Furnish each locker with the following items, unless otherwise shown:
 1. Single Tier Units: Hat shelf, one double prong rear hook and not fewer than 2 single prong side hooks.
 2. Double Tier Units: One double prong rear hook and not fewer than 2 single prong side hooks.
- B. Number Plates: Manufacturer's standard etched, embossed, or stamped, nonferrous metal number plates with numerals not less than 1/2 inches high. Number lockers in sequence as directed by Architect. Attach plates to each locker door, in latch recess, with at least 2 fasteners of same finish as number plate.
- C. Continuous Sloping Tops: Not less than 20 gage sheet steel, approximately 25 degrees pitch, in lengths as long as practicable but not less than 4 lockers. Provide closures at ends. Finish to match lockers.
- D. Trim: Provide trim at jambs and head of recessed lockers, consisting of not less than 18 gage cold rolled steel. Factory finish trim to match lockers. Secure trim to lockers with concealed fastening clips.
- E. Filler Panels: Provide filler panels where indicated, of not less than 18 gage steel sheet, factory fabricated and finished to match locker units.
- F. Base: Where indicated, provide 4" high 16 gage metal base, factory fabricated and finished to match locker units. Recess base from front face of lockers.
- G. Accessible Lockers: For lockers indicated to be accessible, provide shelf in locker located no lower than 9" above finished floor surface. Provide accessibility symbol graphics at exterior of locker door. Completed installation shall comply with requirements of the Americans with Disabilities Act (ADA).

2.05 LOCKER BENCHES

- A. Bench Tops: Provide manufacturer's standard one-piece units, of the following material, minimum 9-1/2 inches wide by 1-1/4 inches thick, with rounded corners and edges:
 - 1. Laminated maple with clear urethane on all surfaces.
- B. Pedestals: Provide manufacturer's standard pedestal supports, with predrilled fastener holes, complete with fasteners and anchors, and as follows:
 - 1. Type: Tubular steel, minimum 1-1/2-inch diameter, threaded on both ends, with standard pipe flange at top and bell-shaped cast base; baked-enamel finish; floor anchored with concealed fasteners.
 - 2. Furnish a minimum of two pedestals for each bench, with spacing not more than 72 inches o.c.
 - 3. Color: Match locker units.

2.06 FABRICATION

- A. Unit Principle: Fabricate each locker with an individual door and frame, individual top, bottom, back, and shelves, and common intermediate uprights separating compartments.
- B. All-Welded Construction: Preassemble lockers by welding all joints, seams, and connections, with no bolts, screws, or rivets used in assembly. Grind exposed welds flush.
- C. Fabricate lockers square, rigid, and without warp, with metal faces flat and free of dents or distortion. Make exposed metal edges free of sharp edges and burrs, and safe to touch. Weld frame members together to form a rigid, one-piece assembly.

2.07 SHEET STEEL FINISHES

- A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond. Use manufacturer's standard methods.
- B. Finish all steel surfaces and accessories, except prefinished stainless-steel and chrome-plated surfaces.
- C. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-enamel finish consisting of a thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 1.4 mils on doors, frames, and legs.
 - 1. Color and Gloss: As selected from manufacturer's full range.
- D. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install lockers and accessories level, plumb, and flush according to manufacturer's written instructions.
- B. Connect groups of all-welded lockers together with no exposed fasteners on face frames.
- C. Anchor lockers to floors and walls at intervals recommended by manufacturer, but not more than 36 inches o.c. Install anchors through backup reinforcing plates where necessary to avoid metal distortion, using concealed fasteners.
- D. Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed lockers with concealed clips.
 2. Attach sloping top units to lockers, with closures at exposed ends.
- E. Attach boxed end panels with concealed fasteners to conceal exposed ends of non-recessed lockers.
- F. Anchor locker benches to floors with pedestals not more than 72 inches apart, and securely fasten to bench top and anchor to floor.

3.02 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.
- B. Clean interior and exposed exterior surfaces and polish stainless-steel and nonferrous-metal surfaces.
- C. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit locker use during construction.
- D. Touch up marred finishes, or replace locker units that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION

SECTION 10 75 00

FLAGPOLES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes ground-set flagpoles made from aluminum.
- B. Related Sections include the following:
 - 1. Section 03 30 00 for "Cast-in-Place Concrete" for concrete footings for flagpoles.

1.02 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide flagpole assemblies, including anchorages and supports, capable of withstanding the effects of wind loads, determined according to NAAMM FP 1001, "Guide Specifications for Design of Metal Flagpoles."
 - 1. Base flagpole design on polyester flags of maximum standard size suitable for use with flagpole or flag size indicated, whichever is more stringent.
 - 2. Basic Wind Speed: 90 mph (3-second gust speed) at 33 feet aboveground.

1.03 SUBMITTALS

- A. Shop Drawings: Include elevations and details showing general arrangement, jointing, fittings and accessories, grounding, and anchoring and supporting systems.
 - 1. Include details of foundation system for ground-set flagpoles.
- B. Structural Calculations: For flagpoles indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. General: Spiral wrap flagpoles with heavy paper and enclose in a hard fiber tube or other protective container.

PART 2 - PRODUCTS

2.01 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. Concord American Flagpole.
 - 2. Morgan-Francis Flagpoles.
 - 3. Admiral Flag Poles, Inc.

2.02 FLAGPOLES

- A. Flagpole Construction, General: Construct flagpoles in one piece.
- B. Exposed Height: 40 feet.

- C. Aluminum Flagpoles: Provide cone-tapered flagpoles fabricated from seamless extruded tubing complying with ASTM B 241, Alloy 6063, with a minimum wall thickness of 3/16 inch. Heat treat after fabrication to comply with ASTM B 597, Temper T6.
- D. Foundation Tube: Galvanized corrugated-steel foundation tube, 0.064-inch minimum nominal wall thickness. Provide with 3/16-inch steel bottom plate and support plate; 3/4-inch- diameter, steel ground spike; and steel centering wedges all welded together. Galvanize steel parts, including foundation tube, after assembly. Provide loose hardwood wedges at top of foundation tube for plumbing pole.
 - 1. Provide flashing collar of same material and finish as flagpole.
- E. Cast-Metal Shoe Base: For anchor-bolt mounting; provide with anchor bolts.
 - 1. Provide units made from same metal and with same finish as flagpoles.
 - 2. Provide ground spike at pavement-mounted metal flagpoles.

2.03 FITTINGS

- A. Finial Ball: Manufacturer's standard flush-seam ball, sized as indicated or, if not indicated, to match flagpole-butt diameter.
 - 1. 0.063-inch spun aluminum, finished to match flagpole.
- B. External Halyard: Ball-bearing, nonfouling, revolving truck assembly of cast metal with continuous 5/16-inch- diameter, braided polypropylene halyard and 9-inch cast-metal cleats with fasteners. Finish exposed metal surfaces to match flagpole.
 - 1. Provide one halyard and one cleat at each flagpole.
 - 2. Provide cast-metal cleat covers, finished to match flagpole, secured with cylinder locks.
- C. Halyard Flag Snaps: Provide two stainless-steel swivel snap hooks per halyard.
 - 1. Provide with neoprene or vinyl covers.

2.04 MISCELLANEOUS MATERIALS

- A. Concrete: Provide concrete composed of portland cement, coarse and fine aggregate, and water mixed in proportions to attain a 28-day compressive strength of not less than 3000 psi, complying with ASTM C 94.
- B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.
- C. Elastomeric Joint Sealant: Single-component urethane joint sealant for Use NT (nontraffic) and for Use M, G, A, and, as applicable to joint substrates indicated, O joint substrates.

2.05 FINISHES

- A. Aluminum: Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 - 1. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Foundation Excavation: Excavate to neat clean lines in undisturbed soil. Remove loose soil and foreign matter from excavation and moisten earth before placing concrete.

- B. Provide forms where required due to unstable soil conditions and for perimeter of flagpole base at grade. Secure and brace forms and foundation tube, sleeve, or anchor bolts in position, to prevent displacement during concreting.
- C. Place concrete immediately after mixing. Compact concrete in place by using vibrators. Moist-cure exposed concrete for not less than seven days or use nonstaining curing compound.
- D. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of concrete base.

3.02 FLAGPOLE INSTALLATION

- A. General: Install flagpoles where shown and according to approved Shop Drawings and manufacturer's written instructions.
- B. Baseplate Installation: Install baseplate on washers placed over leveling nuts on anchor bolts and adjust until flagpole is plumb. After flagpole is plumb, tighten retaining nuts and fill space under baseplate solidly with nonshrink, nonmetallic grout. Finish exposed grout surfaces smooth and slope 45 degrees away from edges of baseplate.

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SECTION 11 16 10

LOADING DOCK EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Dock bumpers.
 - 2. Door track guards.

1.02 SUBMITTALS

- A. Product Data: Include details of construction relative to materials, dimensions of individual components, profiles, and finishes.

PART 2 - PRODUCTS

2.01 DOCK BUMPERS

- A. Laminated-Tread Bumpers: Provide units of 20-inches in height, fabricated from multiple plies cut from fabric-reinforced rubber tires to a uniform thickness of 6-inches. Laminate plies under pressure on 3/4-inch-diameter, steel supporting rods that are welded and bolted to 1/4-inch-thick, structural-steel angle closures with predrilled anchor holes. Acceptable products include:
 - 1. V620-11; APS Resource.
 - 2. LVB620-11; IRONguard Safety Products.
 - 3. RHV620-11; Rite-Hite.

2.02 DOCK ACCESSORIES

- A. Door Track Guards: 48" high, urethane-coated, 1/4 steel plate in z-profile bent shape, with 45 degree bevel, sloped-top safety edge and welded base plate. Acceptable products include:
 - 1. DG48R; Bluff Manufacturing.
 - 2. DT48; Savety Yellow Products.
 - 3. 60-5094; IRONguard Safety Products.
 - 4. OM8048; Omega Industrial Products.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of loading dock equipment.

3.02 INSTALLATION

- A. Attach dock bumpers and track guards to structure in a manner that complies with approved submittals.

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SECTION 12 93 00

SITE FURNISHINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Bicycle Racks.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: Include samples of colors from manufacturer's standard range of colors and finishes.
- C. Shop Drawings: Show installation details and locations for all site furniture.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with local code and regulatory requirements for site furnishing locations and the following:
 - 1. 2010 – ADA Standards for Accessible Design

PART 2 PRODUCTS

2.01 SITE FURNISHINGS

- A. Bicycle Racks: Subject to compliance with requirements, provide products equal to the following:
 - 1. Profile: Inverted U-shape frame fabricated from 2 3/8-inch O.D. pipe.
 - 2. Finish: G-90 galvanized.
 - 3. Mounting: Bolted plate or grouted sleeve type.
 - 4. Spacing: As indicated on Drawings.
 - 5. Approved Manufacturers:
 - a. 1608-01G Rainbow Series; Patterson Williams
 - b. BRWS-101; Victor Stanley.
 - c. Inverted U Bike Rack; Sportworks.

2.02 ACCESSORIES

- 1. Expansion Bolts and Nuts: Stainless steel hex-head bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

2.03 FABRICATION

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field assembly.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners as necessary for securing to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.
- B. Install items square, plumb and accurately fitted together.

3.02 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after installation, clean and repair any damaged surfaces.

END OF SECTION

SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform to applicable provisions of the General Conditions, Special Conditions, and the General Requirements.
- B. Unless otherwise shown on the approved construction documents or otherwise specified, all materials and equipment used in installation of the fire protection system shall be listed and approved for intended service by Underwriters Laboratories, Inc. (UL) and Factory Mutual (FM). All system components shall be standard products of the latest design of the manufacturer. Equipment and material used shall generally be from a consistent manufacturer.
- C. The work included in this contract consists of furnishing all labor, materials, equipment, tools, and services, and includes all costs of permits and all costs whatsoever which may be required to install complete, properly working systems as described herein.
- D. See Division 26 for electrical work and building fire alarm system.
- E. Contractor shall verify prior to preparation of any documents, Insurance Carriers requirements for this project. Such data may be found in general conditions, general requirements, or other portions of the specification manual.
- F. This contract consists of all the system modifications necessary to maintain code compliance.

1.2 GENERAL CONDITIONS AND SPECIAL CONDITIONS

- A. Bidding requirements, general conditions, general requirements, appendices, and addendums apply to the work under this section as depicted in Project Specification Manual.
- B. The Contractor shall examine existing conditions and related work required for the design and installation of the fire protection system required under this section of the Specifications. The contractor shall provide a written report to the Architect describing any conditions which would prevent proper provisions of this work. Commencement of work without reporting unsuitable conditions to the Architect constitutes acceptance of conditions to the Contractor. The Contractor shall be required to perform any necessary removal, repair, or replacement of work caused by unsuitable conditions which is unreported as described herein, at no additional cost to the owner.

1.3 REGULATORY REQUIREMENTS

- A. Hydraulic Calculations and Design Drawings: Calculations and drawings shall be prepared by a qualified registrant and bear the stamp of the Engineer of Record, the approval of the Fire Protection Consultant, the approval of Authority Having Jurisdiction, and (if required) Owner's fire insurance underwriter prior to submittal to Architect and Fire Protection Consultant for their records.
- B. This Contractor is directed to the fact that these specifications are performance type meaning that at the time of submission of bid the Contractor has contacted ALL governing agencies as to the scope of work to be done for the entire project as outlined herein.

- C. If there is a conflict between the referenced standards, codes, or authorities having jurisdiction; then it shall be the Contractor's responsibility to bring the conflict to the attention of the Owner or his/her Agent immediately in an R.F.I. (Request for Information) format for resolution prior to commencement of any additional work.
- D. All work shall conform to the requirements of the applicable portions of the National Fire Protection Association (NFPA) Standards and Recommended Practices (including Appendices) and the Authority having Jurisdiction.
- E. NFPA-13, Current Edition, "Standard for the Installation of Sprinkler Systems".
- F. NFPA-25, Current Edition, "Inspection Testing and Maintenance of Water-Based Fire Protection Systems".
- G. All work, materials, and equipment shall conform to all Local, State and Federal Codes as well as all other Authorities having jurisdiction. If alternate editions of aforementioned standards, or additional standards are required then they shall be applied as accepted by Local and State codes.
- H. The Contractor shall be responsible for filing all documents, paying all fees, and securing all permits, inspections, and approvals necessary for conducting this work.

1.4 EXTRA MATERIALS

- A. Furnish under provisions of Division 1.
- B. Provide extra sprinklers under the provisions of NFPA 13. In addition, a minimum of two (2) spare sprinklers of each type and temperature installed shall be provided.
- C. Provide two (2) spare suitable wrenches for each sprinkler type.
- D. Provide metal storage cabinet in location designated by Architect/Owner's representative.

1.5 INTENT OF SPECIFICATIONS

- A. It is intended that the work performed pursuant to these specifications shall be complete in every respect; resulting in a system installed entirely in accordance with all current applicable codes, standards, manufacturer's recommendations and U.L. listings and FM approvals. All work in general consists of, but is not necessarily limited to, these specifications and the latest accepted code approved design and installation standards.
- B. It is further intended that upon completion of work, the Owner shall be provided with the following:
 - 1. Complete information and drawings describing and depicting the entire system as installed, including all information necessary for maintaining, troubleshooting, and expanding the system at a future date.
 - 2. Complete documentation of system testing.
 - 3. Written certification that the system has been tested and inspected is installed entirely in accordance with the applicable codes, standards, manufacturer's recommendations, U.L. listings, F.M. approvals, etc. and is in proper working order.
 - 4. It is intended that the Contractor be responsible for work with other trades.

1.6 WORK TO BE PERFORMED

- A. Modify existing automatic sprinklers according to these specifications and/or drawings. Including, but not limited to the following:
1. Shop drawings, fabrication drawings, equipment submittals, record drawings and other submittals required herein.
 2. Testing of the existing automatic sprinkler system.
 3. Guarantee all new equipment and systems for a one-year period after the date of substantial completion as determined by Architect, Owner or His/her Agent and Contractor.
 4. Repair all damage resulting from this work, Including all materials, fittings, and fixtures. All pipe openings shall be closed so as to prevent obstructions and damage.
 5. Inserts, hangers, clamps, earthquake sway bracing, etc., as required to hang and support piping in accordance with NFPA and/or this specification.
 6. Accuracy of prefabricated pipe, location of sprinklers and deflectors (per NFPA and inspections), field fit of piping, piping elevations, riser nipple lengths and dimensioning.
 7. For remodel projects, verify with the architect if existing sprinklers are to remain or are to be replaced with new. New sprinklers to match any existing that remain.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Installation and alterations of fire protection piping, equipment, specialties, accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified means experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with all precautions required and has complied with all the requirements of the Authorities having jurisdiction. The installer shall be licensed with the State and Local Authorities having jurisdiction. Submit evidence of such qualifications to the Owner or his/her Agent with submission of bid.

1.8 DEFINITIONS

- A. Contractor: The Fire Protection Contractor and any of his/her sub-contractors, vendors, suppliers, or fabricators.
- B. Provide: Furnish and install.
- C. Furnish: Purchase and deliver to other trades or Owner for installation.
- D. Install: Install materials, equipment or assemblies furnished by other trades or Owner.
- E. Concealed: Where used in connection with installation of piping and accessories, shall mean that hidden from sight as in chases, furred spaces, pipe shafts, or above suspended ceilings. "Exposed" shall mean "not concealed" as defined above.
- F. Owner: Owner or his/her designated Representative.
- G. Fire Protection Consultant
1. Kraemer Consulting Engineers, PLLC.

1.9 SUBMITTALS FOR ENGINEER REVIEW

- A. Within 30 days after award of contract, the Contractor shall submit manufacturer's data sheets, hydraulic calculations, catalog cut sheets, shop drawings and data on devices for all necessary approvals prior to fabrication of materials, refer to Division 1 for quantities and format.
- B. Hydraulic Calculations and Design Drawings: Calculations and drawings shall be prepared by a qualified registrant and bear the stamp of the Engineer of Record, the approval of the Fire Protection Consultant, the approval of Authority Having Jurisdiction, and (if required) Owner's fire insurance underwriter prior to submittal to Architect and Fire Protection Consultant for their records.
- C. Contractor shall submit complete packages. Partial submittals will be returned without further explanation.
- D. Drawings shall have the Fire Protection Consultants stamp of approval prior to submittal to the Authority Having Jurisdiction.
- E. No extension of the contract time will be granted for the Contractor's failure to allow sufficient time for review and processing, or for shop drawings which have been returned due to improper submission.
- F. The Contractor will not be authorized to start any portion of the work until the shop/fabrication drawings, catalog cuts and other required submittals for that portion are received, reviewed, and approved by all required parties.
- G. The Owner or his/her Agent, Architect and Fire Protection Consultant shall review all submittals for conformance to these specifications.
- H. Contractor may submit for review and approval any proposed substitution of materials from that specified, with material submittals.
- I. If submittals or proposed substitutions, upon review, are found not to conform to the requirements of these specifications, the Contractor shall be required to resubmit with modification. The Contractor shall be responsible for the Owner's expenses for subsequent revisions of rejected submittals necessitated by the Contractor's failure to make the requested modifications. Such extra fees shall be deducted from payments by the Owner to the Contractor.
 - 1. REVIEWED - NO EXCEPTIONS (Contractor Resubmittal Not Required)
Reviewed manufacturer and equipment specifications. Appears to be in conformance with design drawings/specifications.
 - 2. REVIEWED - MAKE CORRECTIONS NOTED (Contractor Resubmittal Not Required)
Reviewed manufacturer and equipment specifications. Appears to be in conformance with design drawings/specifications. Minor adjustments required to the equipment options/accessories. Resubmittal is not required if written acknowledgement is sent to the General Contractor and Architect that these items will be provided as corrected. The sub-contractor shall also provide final record submittal to the general contractor.
 - 3. REVIEWED - FOR RECORD ONLY (Contractor Resubmittal Not Required)
Reviewed only for coordination purpose only of another trade engineering submittals or contractor generated shop-drawings. (Often these are contractor generated installation drawings or 3rd party sealed design drawings (typically seismic engineering for MEP equipment/piping).
 - 4. REVISE & RESUBMIT (Contractor Resubmittal Required)
Specific manufacturer is acceptable. Equipment model, application, capacity, design parameters, code listing, testing listing is not acceptable or not provided. Resubmittal is required and all engineers' comments shall be addressed in summary memo attached with the resubmittal.

5. REJECTED (Contractor Resubmittal Required)
Specific manufacturer is not acceptable and rejected. The manufacturer is not listed within project specs and was not prior approved within the timeframe required. Other model types/applications produced by the manufacturer will not be accepted.

J. Contractor shall address all comments in written form and include with any resubmittal.

K. One set of drawings bearing the Fire Protection Consultant's approval stamp, Engineer of Record stamp, and the approval of the Authority Having Jurisdiction shall be submitted to the Engineer and Architect for their records.

1.10 MANUFACTURER'S DATA

A. The Contractor shall submit, with his/her bid, manufacturer's data sheets showing the type and model of all equipment or material proposed. This information shall include, but not be limited to:

1. Type of pipe.
2. Hangers.
3. Valves.
4. Pipe fittings/joining methods.
5. Sprinklers.
6. Escutcheons.
7. Fire rated and waterproof penetration seals.
8. Nozzles (where required).

B. When a data sheet shows more than one product, the proposed product shall be clearly indicated by arrows or other suitable means. This includes sprinkler orifice sizes, finishes, and temperature ratings.

1.11 SHOP/FABRICATION DRAWINGS

A. Shop/Fabrication drawings shall be at a minimum scale of 1/8 inch equals 1'-0" for plans. Plans shall include all required information as required in NFPA-13. Provide additional sprinklers (over code minimum quantities) to obtain symmetrical ceiling layouts. Provide sprinklers as required, in accordance with NFPA-13 for obstructions and ductwork.

B. Design shall be based upon all the latest architectural, structural, heating and ventilating, plumbing, electrical and owner's fixture, rack, and equipment drawings, including addendums, etc.

1.12 OPERATION AND MAINTENANCE MANUAL

A. Within 30 days of completion of the work, the Contractor shall provide the Owner with one (1) electronic copy (in pdf format) copy of a manual including, but not limited to:

1. 11"x17" reduced copies of the "record" drawings.
2. A detailed description of routine maintenance required or recommended, or as would be provided under a maintenance schedule and detailed maintenance and installation manuals/instructions for all equipment installed including a list of recommended spare parts and service directory

B. Within 30 days of the completion of the work, one (1) electronic copy of the manual shall be delivered to the Owner.

1.13 RECORD DRAWINGS

- A. The Contractor shall maintain on the site an accurate record of all changes made to the system layout from that shown on the approved drawings.
- B. At least one set of approved drawings with all required stamps of approval shall be maintained on-site and made available to all Authorities having jurisdiction on demand during the construction phase of work.

1.14 VALVE DIAGRAMS

- A. At the completion of the work, provide a small scale of the building(s) indicating the location of all control valves, low point drain(s), and inspectors test(s). The plan shall be neatly drawn, and color coded to indicate the portion of the building protected by each system, framed under glass (not plastic), and permanently mounted on the wall adjacent to each sprinkler riser.

1.15 CHANGES

- A. Make no changes in installation from layout as shown on the approved drawings unless change is specifically approved by the Engineer. This does not include minor revisions for the purpose of coordination, or to clear ducts or obstructions.
- B. Any changes made other than stated above are at the Contractor's own expense and responsibility.

1.16 LEAK DAMAGE

- A. The Contractor shall be responsible during the installation and testing period of the sprinkler system for any damage to the work by others, to the building, its contents, etc. caused by leaks in any equipment, by unplugged or disconnected pipes, fittings, etc., or by overflow, and shall pay for the necessary replacement or repairs to work of others, damaged by such leaks.

1.17 FREIGHT AND HAULING

- A. Deliver materials to the job site, unload, and store in a location determined by the Owner's Representative and General Contractor.

1.18 BASE BID

- A. The base bid shall be lump-sum or in accordance with Division I of specifications.
- B. The Contractor shall indicate the number of sprinklers included in the base bid, including the number of sprinklers allowed for obstructions and ductwork.

1.19 CLEANUP

- A. Maintain the premises free from accumulation of waste material or rubbish caused by this work.
- B. At the completion of the work, remove all surplus materials, grease, oil, etc. from piping, tools, etc., and leave premises in a neat, clean workmanlike manner.

1.20 SAFETY

- A. All work shall be performed in compliance with the Occupational Safety and Health Act of 1970 and Construction Safety Acts Standards (or current).

1.21 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and protect products to site under provisions of Division 1.
- B. Store products in shipping containers and maintain them in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.22 EMERGENCY SERVICE

- A. During the warranty period, the Contractor shall provide emergency repair service for the entire automatic sprinkler system. This service shall be provided on a 24-hour per day, 7 day per week basis. Coordinate details with Owner's Representative.

1.23 SPARE PARTS AND SPECIAL TOOLS

- A. Contractor shall install code approved metal sprinkler cabinet(s) containing sprinklers of all types, finishes, and temperature ratings used and two (2) sets of sprinkler wrenches compatible with each type of sprinkler provided. The cabinets shall be installed at the locations approved by the Owner and NFPA requirements. Sprinkler and cabinet quantities shall be per NFPA-13.
- B. The Contractor shall supply the Owner with two (2) complete sets of special tools and equipment necessary to perform routine maintenance on the sprinkler systems.

1.24 FINAL APPROVAL AND ACCEPTANCE

- A. Final approval and acceptance of the work will not be given by the Owner until:
 - 1. The completed sprinkler system(s) has/have been inspected, tested, and approved by the Owner, Architect, and all other Authorities having jurisdiction.
 - 2. Required submittals, system operation and maintenance manuals, "record" drawings, spare parts, and special tools have been provided to, reviewed, and accepted by the Owner.

1.25 GUARANTEE PERIOD

- A. The following guarantee is a part of the specifications and shall be binding on the Contractor.
- B. "The Contractor guarantees that this installation is free from mechanical defects. He agrees to replace or repair to the satisfaction of the Architect any part of the installation which may fail within a period of one year after date established below, provided that such failure is due to defects in the materials and workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor furnished equipment, or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first."

PART 2 PRODUCTS

2.1 DESIGN CRITERIA

- A. Provide wet-pipe sprinklers in all areas as required by NFPA, Authorities having jurisdiction, these specifications and/or approved construction documents.
 - 1. Provide ESFR wet pipe system over warehouse area. Refer to NFPA 13 and FM Global Data sheet 2-2 for spacing requirements.
 - 2. Provide wet pipe system over office areas conforming to NFPA 13 and FM Global data sheet 3-26.
 - 3.

2.2 PIPING

A. Manufacturers:

1. Western Tube and Conduit Corp.
2. Bull Moose Tube Company

- B. Sprinkler system piping or tubing shall meet the requirements of NFPA 13, be U.L. listed and F.M. approved. Contractor shall base his/her bid on the use of any one or a combination of the following: In addition, all pipes shall have a minimum Corrosion Resistance Ratio (CRR) of 1.00 or greater, as per U.L. listings.
- C. Pipe meeting ASTM A-795 and/or A-135 requirements for above grade use. All piping shall be black carbon steel.
- D. Flanges and flanged fittings shall be 175 psi cast iron with standard ring gaskets.
- E. Pipe and fittings shall be listed by Underwriters Laboratories, Inc. and approved by Factory Mutual for use in fire protection systems and designed to withstand a working pressure of not less than 175 psi.
- F. All pipes and fittings exposed to the weather, downstream of all inspector's test valves, between exterior wall and check valve on FDC, or located in a corrosive atmosphere shall be hot-dipped zinc coated (galvanized).
- G. Flexible couplings shall be U.L. and F.M. approved.
- H. Pipe penetrations through masonry and fire rated construction shall be sleeved and sealed with fire rated seals commensurate with the building construction.
- I. Pipe penetrations through floors and exterior walls shall be approved waterproof seals.
- J. When system piping pierces a foundation wall below grade or is located under the foundation wall, clearance shall be provided to prevent breakage of piping due to building settlement. Do not locate pipe joints within or under a foundation wall and a 1–3-inch clearance shall be provided around piping by use of sleeve for piping piercing a foundation wall. Sleeve properly and fill the clear space with approved waterproof packing.
- K. Use of foreign-made piping or fittings shall not be permitted.
- L. Use of copper or CPVC piping and fittings in accordance with NFPA-13 and pipe listing is permissible where prior-approved only.

2.3 SPRINKLERS

A. Manufacturers:

1. Viking
2. Reliable
3. Tyco
4. Victaulic

B. Ceiling (Recessed Light Fixtures):

1. Type: Recessed Pendant type with matching escutcheon plate.
2. Sprinkler Finish: Chrome plated.
3. Escutcheon Plate Finish: Chrome plated.
4. Activation: Recessed: Glass bulb type temperature rated for specific area hazard.

- C. Ceiling (Surface mounted light fixtures):
1. Type: Standard pendent type with matching escutcheon plate.
 2. Sprinkler Finish: Chrome plate.
 3. Escutcheon Plate Finish: Chrome plated.
 4. Activation: Recessed: Glass bulb type temperature rated for specific area Hazard.
- D. Hard Lid Ceiling (Interior):
1. Type: Flat-Plate Concealed with escutcheon painted to match ceiling.
 2. Sprinkler Finish: Brass.
 3. Escutcheon Plate Finish: Painted to match ceiling
- E. Exposed Area Type:
1. Type: Upright type.
 2. Sprinkler Finish: Brass.
 3. Activation: Glass bulb type temperature rated for specific area hazard.
- F. Sidewall Type:
1. Type: Recessed horizontal sidewall type with matching escutcheon plate and guard.
 2. Sprinkler Finish: Chrome.
 3. Escutcheon Plate Finish: Chrome.
 4. Activation: Glass bulb type temperature rated for specific area hazard.
- G. Guards: Finish to match sprinkler. Provide where the sprinkler is susceptible to mechanical damage and/or located at less than 7'-0" above floor.
- H. In exposed areas and ceilings, sprinkler activation shall be glass bulb type.
- I. All sprinkler colors shall be factory – applied.
- J. Utilize quick response sprinklers where possible in accordance with NFPA 13.
- K. Sprinklers required due to ceiling projections/obstructions and ductwork are not considered additional sprinklers. The contractor shall be responsible for identifying these locations and providing coverage per code.
- L. Install ordinary, intermediate, and high temperature sprinklers of proper degree rating wherever necessary to meet requirements of NFPA, and Authorities having jurisdiction.
- M. Provide corrosion resistant sprinklers with factory applied coating where sprinkler is in corrosive atmosphere (locker/shower areas, canopies, etc.).
- N. Provide dry pendent sprinklers with wire guards in all areas where the maintained ambient temperature is less than 40 degrees Fahrenheit; this includes walk-in refrigerators and freezers.
- O. Provide dry pendent sprinklers on dry systems.
- P. Sprinkler and escutcheon finishes shall be suitable for area or ceiling finish provided. Verify finish of all sprinklers and escutcheons with Owner or his/her Agent prior to ordering.

2.4 HANGERS

- A. Use beam clamps or hang from top chord of joists. Do not hang from bottom chord of joist or bridging.
- B. Trapeze all mains. Verify all hanger types with Structural Drawings and Engineer prior to commencement of any work.
- C. Provide sway bracing. Install in accordance with NFPA-13. Pipe to be generally supported by clamps and rods and secured to overhead construction.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Installation of fire protection systems shall conform to the requirements of the applicable provisions of NFPA and in accordance with Chapter 38 of the Uniform Building Code.
- B. The arrangements of all piping systems shall conform to the architectural requirements and field conditions, and shall be run straight and direct, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be provided where required. Standard fittings shall be used for offsets. All risers shall be erected plumb and true and shall be parallel with the walls and other pipes and shall be neatly spaced. All work shall be coordinated with all sections of Division 15, Mechanical, and Division 16, Electrical, in order to avoid interference of pipe and unnecessary cutting of floors and walls.
- C. Installation of mechanical and fire protection system within the ceiling cavity is in the following order of priority:
 - 1. Plumbing soil, waste, and roof drain lines.
 - 2. Supply, return and exhaust ductwork.
 - 3. Steam and condensate piping.
 - 4. Heating hot water and chilled water piping.
 - 5. Lighting, bus ducts and electrical cable trays.
 - 6. Fire sprinkler mains.
 - 7. Domestic hot and cold-water mains.
 - 8. Vent piping (for waste systems).
 - 9. Fire sprinkler branch piping.
 - 10. Domestic hot and cold-water branch piping.
 - 11. Special piping systems (such as medical gas).
 - 12. Pneumatic control piping.
- D. The Fire Protection Contractor shall respect these priorities. Shop prefabrication of the sprinkler system is at the Contractor's own risk. If any field modifications are required to accommodate other trades, those modifications will be at the Contractor's own expense. All offsets of the sprinkler piping shall be provided with proper (as per NFPA) drains and air relief.

3.2 TEMPORARY FIRE PROTECTION

- A. During the construction of the building and until the permanent fire extinguishing system has been installed and is in service, temporary fire protection shall be provided as required by the Fire Marshal.

3.3 APPROVALS

- A. Upon completion of testing of this system, the Contractor shall furnish the Architect with a Certificate of Approval from the legally constituted authorities having jurisdiction.

3.4 GENERAL

- A. Sprinkler spacing in tiles at center of 2'-0" direction and at quarter points in the 4'-0" tile direction shall be acceptable.
- B. Sprinklers in finished areas are to be installed on a true axis line in both directions with a maximum deviation from the axis line of 1/2", plus or minus. Heads exceeding this, as directed by the Architect, shall be removed and reinstalled.
- C. Apply masking tape, plastic covers (available from many sprinkler manufacturers) or paper cover to ensure sprinkler's and/or cover plates do not receive field paint finish.
- D. All holes made by the Contractor in any wall, ceiling or floor shall be patched by the Contractor, restoring the wall, ceiling or floor to its original condition, fire resistance and integrity.
- E. Removal and repair of all finished surfaces shall be coordinated with the Architect and subject to his/her approval.

3.5 STARTING AND COMPLETION DATES

- A. The schedule for installation of the sprinkler systems will be established at the pre-bid meeting. Coordinate schedules closely with General Contractor, Owner, and Architect.

3.6 INSPECTION

- A. The Contractor shall daily examine all areas in which the work will be performed. The Contractor shall immediately report unsatisfactory working conditions to the Owner or his/her Agent for resolution. The Contractor shall not proceed with the work until all unsatisfactory working conditions have been corrected.
- B. Owner, Architect, and all Authorities having jurisdiction shall be allowed to conduct inspections and tests as they choose. Approved sprinkler plans must be available on the project site during installation and inspection of the work.

3.7 GENERAL PREPARATION

- A. Coordinate the work of this Section with other affected work.

3.8 PIPING PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.9 PIPING INSTALLATION

- A. Install piping in accordance with NFPA 13 for sprinkler systems, NFPA 14 for standpipe and hose systems and NFPA 24 for service mains.
- B. Route piping in orderly manner plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space and not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.

- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Slope piping and arrange systems to drain at low points.
- G. System shall be designed to allow for expansion and contraction.
- H. Prepare pipe, fittings, supports, and accessories for finished painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Division 9.
- I. Do not penetrate building structural members unless indicated in writing by Structural Engineer of record.
- J. Provide sleeves when penetrating footings, floors and/or walls. Seal pipe and sleeve penetration to achieve fire resistance equivalent to fire separation required.
- K. Die cut screw joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- L. Install valves with stems upright or horizontal, not inverted. Remove protective coatings after installation.
- M. Provide gate or butterfly valves for shut-off valves or isolating service.
- N. Provide drain valves at main shut-off valves, low points of piping and apparatus.
- O. Installation or use of unidentified or foreign-made pipe, tube, or fittings is not permissible.
- P. Where sprinkler piping is installed in finished areas, the Contractor shall install all new piping so that it is concealed above finished ceilings; provide a minimum separation of 12" between the ceiling height and the bottom of the sprinkler pipe. Pipe installed in unfinished areas may be exposed.
- Q. All exposed pipes which pass through a wall, ceiling, or floor shall be provided with escutcheon plates.
- R. All piping shall be installed so as not to obstruct any portion of a window, doorway, stairway, or passageway, and shall not interfere with the operation or accessibility of any mechanical, plumbing, or electrical equipment. Run piping horizontally and at right angles to walls and ceilings or along slope of ceilings.
- S. Center sprinklers in both horizontal directions with respect to ceiling components, such as ceiling grid (in center tile of 2'-0" direction and at quarter points of 4'-0" direction), light fixtures, HVAC diffusers, speakers and detectors as required.
- T. All sprinkler piping, drain and test piping, etc. installed through exterior walls shall be galvanized and have a 4'-0" minimum length to first valve located inside insulated building envelope.
- U. All sprinkler piping must be substantially supported from building structure and only approved type hangers shall be used. Sprinkler lines under ducts shall not be supported from ductwork but shall be supported from building structure with trapeze hangers where necessary, in accordance with NFPA-13. Tapping or drilling of structural elements is not permitted. Use beam clamps or hang from top chord of joist. Do not hang from bottom chord of joist.
- V. Pendent sprinklers shall be in alignment with, and parallel to, ceiling fixtures, walls, etc.
- W. Install sprinkler piping in exposed areas as high as possible using necessary fittings and auxiliary drains to maintain maximum clear head room, and to keep space aesthetically acceptable to Architect/Owner.

- X. Sprinklers shall be installed per the requirements of NFPA 13 with regard to ducts, obstructions, steel beams and joists, partitions, and ceiling projections. Provide additional sprinklers as required.
- Y. Provide sprinkler protection below any ducts, banks of piping, etc., meeting obstruction requirements of FM Global and NFPA 13.
- Z. Contractor shall provide complete sprinkler protection before combustible contents are moved into the building.
- AA. All sprinkler piping and fittings shall be installed so that the system may be drained. System shall primarily be designed to drain through main drain at riser(s).
- BB. Minimum and maximum deflector distances shall be per FM Global and NFPA requirements.
- CC. A minimum distance between sprinklers, as required by NFPA and the individual sprinkler U.L. listing or F.M. approval, shall be provided to avoid cold soldering of sprinklers.
- DD. Provide fire protection during construction as required by local Authorities having jurisdiction.
- EE. Where the building is to be built as a shell type building, the Contractor shall provide a complete and working sprinkler system such that the only work required by the Owner to complete the sprinkler system will be the addition of pipe drops and sprinklers in the Tenant ceiling spaces when the future ceilings are added. Outlets shall be sized adequately (1" min.) and bushed for future connection. The Contractor is instructed to review the Architectural and Structural Drawings and determine as to which ceilings are to be finished at this time or will be finished at a later date. The Contractor shall adjust his/her design accordingly and incorporate the addition of the future Tenant spaces in his/her design. Where the building is not to be built out as shell type areas, disregard this paragraph.

3.10 SYSTEM DRAINS

- A. Provide all auxiliary drains where necessary, extend and terminate at a safe location.
- B. Provide 1/2" minimum pressure relief valve and drains on each riser supplying all systems.
- C. Pipe all drains to a location where water drained will not damage stock, equipment, vehicles, planted areas, etc., injure personnel, or patrons, or cause an unsightly wet area in front of any entrances.
- D. Plugs used for auxiliary drains shall be brass.
- E. Pressure relief and main drains shall not be interconnected.

3.11 CEILING AND WALL PLATES

- A. Install chrome wall plates wherever exposed sprinkler piping passes throughout ceiling and walls.

3.12 SLEEVES

- A. Set sleeves securely in place for all pipes passing through floor and masonry wall openings.
- B. Space between sleeve and pipe shall be filled with packing commensurate with construction. Provide chrome wall plates at each side of wall.
- C. Sleeves and seals through floors and exterior wall shall be watertight.
- D. All sleeves shall meet the requirements of all Authorities having jurisdiction and Owner.

3.13 WELDING AND FLAME CUTTING

- A. No welding or flame cutting by the Contractor shall be permitted on the premises.
- B. Shop welding (off-site) shall meet all NFPA-13 and related requirements. Retrieve all discs from piping prior to site delivery.

3.14 FINAL INSPECTION AND TESTS

- A. Overhead sprinkler piping: Tested for a period of two hours at a hydrostatic pressure of 200 lbs. and all piping, valves, sprinklers, etc., shall be watertight.
- B. Replace piping system components which do not pass the test procedures specified, and retest repaired portion(s) of the system.
- C. The Contractor shall make arrangements with all Authorities having jurisdiction for final inspection and witnessing of the final acceptance tests.
- D. If, when the Owner's consultant or any other Authorities having jurisdiction visit the job site for this purpose after being advised by the Contractor that the work is completed and ready for test, the work has not been completed, or the final acceptance tests are unsatisfactory, the Contractor shall be responsible for Consultant's extra time and expenses for reinspection and witnessing the retesting of the work. Such extra fees shall be deducted from payments by the Owner to the Contractor.
- E. Contractor shall provide at least (5) working days notice to Architect and Owner via General Contractor for all tests and field observations.

END OF SECTION

SECTION 22 01 00

GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and the General Requirements.

1.2 RELATED SECTIONS

- A. See Section 22 01 20, Trenching and Backfill for Mechanical Systems.
- B. See Section 22 05 23, Valves.
- C. See Section 22 07 00, Plumbing Systems Insulation.
- D. See Section 22 11 00, Building Water Supply System.
- E. See Section 22 13 00, Building Soil and Waste System.

1.3 SCOPE

- A. Plumbing fixtures and equipment shall be supplied, set and connected as shown on the plans, shall meet all local and state code requirements, and as recommended by the equipment manufacturer. Fixtures and equipment shall be protected from damage during construction, and shall be thoroughly cleaned of all tape, paint and adhesive prior to final acceptance.
- B. The work included in this contract consists of furnishing all labor, materials, equipment, and tools, to completely install and place in operation the fixtures and equipment described herein.
- C. Equipment and Fixture Connections: The Contractor shall be responsible for rough-in and connection to the equipment furnished by the Owner, by others, or as under the other Sections of this specification. This shall include any equipment requiring connection to domestic hot or cold water systems, direct or indirect waste, or vent piping, as shown on the Architectural, Plumbing or Mechanical drawings. The Contractor shall coordinate his rough-in work with the Supplier of the equipment actually being furnished, and shall conform to the service requirements of furnished equipment. All final connections required by such equipment shall be made and tested by the Contractor. Carefully review the Architectural drawings for equipment and fixture locations. The rough-ins and equipment installation that applies to ADA fixtures shall comply with all local and state requirements.
- D. The Contractor shall extend condensate drain lines from all air conditioning equipment as shown on the drawings.

1.4 UNDERGROUND PIPING SYSTEM IDENTIFICATION

- A. All underground facilities shall be locatable above ground without potholing. "Underground Facility" means any item of personal property that is buried or placed below ground for use in connection with the storage or conveyance of water, sewage, oil, gas or other substances, and shall include but not be limited to pipes, sewers, valves, lines, manholes, etc., and landscape irrigation systems of two inches in diameter or less. Metallic gas service lines installed on private property by the utility company are detectable without the following requirements:
1. All buried nonmetallic private water lines and nonmetallic fire lines shall have a blue #18 insulated tracer wire securely attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and be securely attached at that point.
 2. All buried nonmetallic private sewer lines shall have a green #18 insulated tracer wire attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and be securely attached at that point.
 3. All buried nonmetallic private gas line shall have a yellow #18 insulated tracer wire attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and securely attached at that point.
 4. All buried nonmetallic private landscape sprinkler lines greater than 2" in diameter shall have a purple #18 insulated tracer wire securely attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and be securely attached at that point.
 5. All nonmetallic underground facilities including but not limited to mechanical, oil, chilled water, refrigerants, steam, or empty conduit shall have a white #18 insulated tracer wire attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and be securely attached at that point.
- B. Where an installation of any of the above referenced items connects to a public utilities service facility that does not re-emerge above grade the tracer wire shall be securely attached at the point of such transition. Where the lines extend under a building without re-emerging above grade prior to entering a building the tracer wire shall be securely attached at the point where the transition occurs.
- C. Please note that these particular requirements pertain to underground facilities on private property and will be regulated by the Building Official (Building Department). They are in addition to requirements required by the Authority Having Jurisdiction. City of Colorado Springs adopted codes.
- D. Detectable requirements for underground facilities in rights of way will be regulated and monitored by the Authority Having Jurisdiction. City of Colorado Springs Engineering Department.

1.5 IDENTIFICATION OF PIPING

- A. All exposed piping and piping concealed above accessible ceilings shall be labeled at 15 ft. intervals. In addition, piping concealed above rigid ceilings and inside walls and chases shall be labeled at each access door. Brady, Brimar, or accepted equivalent labels, as specified herein shall be used.

1.6 IDENTIFICATION OF VALVES

- A. Each valve shall be provided with a tag secured to the valve with metal chain or copper wire. Tag shall indicate both the service and function of each valve. Contractor shall furnish two sets of prints of drawing and showing floor plan for each floor with all valves accurately located and labeled. Drawing shall be submitted to the Architect in accordance with the requirements specified under Paragraph "Operating and Maintenance Instructions" in this Section. These drawings shall be neat and easily read. Tags shall be stamped brass plastic (1-1/2" or 2" diameter) with 1/4" high figures.

1.7 SUBMITTALS

- A. See Division 1 for additional submission requirements.
- B. The Contractor shall submit a one (1) electronic copy (pdf format) of submittal brochures for review, or as indicated in Division 1. Brochures shall be submitted within (Thirty) 30 days after contract award, or as indicated in Division 1.
- C. All submittals shall be submitted at one time. Partial submittals shall be returned to the Contractor unreviewed for completion and resubmittal.
- D. Complete data must be furnished showing quality, dimensions, complete certified characteristics of equipment, capacity, code requirements, motor drives, and certified performance curves for all fans and pumps. No equipment or materials shall be purchased prior to receiving written notification from the Architect that submittals have been reviewed and marked as follows:
 - 1. REVIEWED - NO EXCEPTIONS (Contractor Resubmittal Not Required)
Reviewed manufacturer and equipment specifications. Appears to be in conformance with design drawings/specifications.
 - 2. REVIEWED - MAKE CORRECTIONS NOTED (Contractor Resubmittal Not Required)
Reviewed manufacturer and equipment specifications. Appears to be in conformance with design drawings/specifications. Minor adjustments required to the equipment options/accessories. Resubmittal not required if written acknowledgement is sent to the General Contractor and Architect that this items will be provided as corrected. Sub-contractor shall also provide final record submittal to the general contractor.
 - 3. REVIEWED - FOR RECORD ONLY (Contractor Resubmittal Not Required)
Reviewed only for coordination purpose only of another trade engineering submittals or contractor generated shop-drawings. (Often these are contractor generated installation drawings or 3rd party sealed design drawings (typically seismic engineering for MEP equipment/piping).
 - 4. REVISE & RESUBMIT (Contractor Resubmittal Required)
Specific manufacturer is acceptable. Equipment model, application, capacity, design parameters, code listing, testing listing is not acceptable or not provided. Resubmittal is required and all engineers' comments shall be addressed in summary memo attached with the resubmittal.
 - 5. REJECTED (Contractor Resubmittal Required)
Specific manufacturer is not acceptable and rejected. Manufacturer is not listed within project specs and was not prior approved within the timeframe required. Other model types/applications produced by the is manufacturer will not be accepted.
- E. Review and Approval of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and with the information indicated on the Drawings and stated in the Specifications. Approval of a separate item as such will not indicate approval of the assembly in which the item functions. Approval of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor shall approval relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including a minimum of 4 feet clear in front of all electrical control equipment and panels, for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the Work.
- F. Use of accepted substitutions does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from accepted substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

- G. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" fabrication drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted and accepted by the Architect before construction begins.
- H. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior approval or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received written approval, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no extra cost to the Owner.
- J. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES AND EQUIPMENT

- A. Plumbing fixtures, circulating pumps, water heaters, and all other plumbing equipment shall be as specified in this section, on the plans, or an accepted equivalent.

2.2 QUALITY ASSURANCE

- A. Written prior acceptance shall be required for all item substitutions. The contractor shall submit in writing all proposed substitutions 10 days prior to bid date.
- B. Final acceptance of substituted equipment is contingent upon review and acceptance by the Engineer and the satisfactory operation of the equipment when the installation is completed. Engineer acceptance shall in no way relieve the manufacturer from complying with all the provisions of the plans (including space requirements) and specifications. The substitutes of the following manufacturers of fixtures, equipment and material are acceptable to bid against the manufacturers specified.

<u>ITEM OF MATERIAL OR EQUIPMENT</u>	<u>ACCEPTABLE MANUFACTURER</u>
Plumbing Fixtures	American Standard, Eljer, Crane, Kohler
Water Heaters	A. O. Smith, Patterson-Kelly, W e b e n - J a r c o , Lochinvar, Teledyne Laars, Aerco, Raypac, State, National, RUUD Bradford- White,
Thermal Expansion Tank	Watts, Amtrol, B&G, Taco, Armstrong, Expanflex, MEPCO,
Access Panels	Zurn, Krueger, Williams Brothers, Mifab
Cast Iron Castings	Neenah, McKinley, Vulcan, Bilco, Alhambra Foundry
Hydrants (Wall, Post or Box)	Zurn, Wade, Josam, J.R. Smith, Woodford,
Hose Bibbs	Woodford, Chicago Faucet, T&S, Royal, Grohe, Mifab
Sump Pumps	Paco, Flygt, Ebara, Weil, Enpo, Peerless, Hydro-Matic

Floor Drains, Floor Sinks, Roof Drains, Downspout Nozzle, Cleanouts, Chair Carriers, Backwater Valves, Air Gap Fittings, Water Hammer Arrestors, Trap Primers	Zurn, Wade, Josam, J.R. Smith, Ancon, Mifab
Water Closet Seats	Church, Beneke, Olsonite, Bemis, Sperzel
Flush Valves	Sloan "Royal", Delany "Flush Boy" with self cleaning diaphragm.
Faucets	Delta, Moen, T&S, Kohler, Speakman, Chicago, Symmons, Elkay, Royal Brass Note: Only ceramic cartridge type of faucets may be substituted. Any other system will not be accepted.
Stops, Traps, Grids, ADA Wrap	McGuire, Sani-Dash, Brass Craft, Dearborne, Engineered Brass Company (EBC), TrueBro
Backflow Preventers	Febco, Wilkins, Orion, Watts, Beeco, Conbraco
Electric Water Coolers	Haws, Oasis, Elkay, Sunrock
Mop Basin Receptors	Fiat, Williams, Oberon

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures connecting fittings, piping and valves shall be brass or copper and, whenever exposed, shall be polished chrome-plated. Provide tight fitting wall or floor escutcheons of chrome-plated brass wherever pipes pass through floors, wall or ceilings.
- B. Equipment connecting fittings, piping and valves whenever exposed in occupied areas, except in equipment rooms, shall be chrome-plated. Painting may be used only if specifically accepted by the Architect or Engineer.
- C. All porcelain or vitreous china shall be clean, smooth and bright. All shall be warranted not to craze, discolor or scale.
- D. The Contractor shall furnish and install all required water, waste, soil and vent connections to all plumbing fixtures together with all fittings, supports, fastening devices, cocks, valves, traps, etc., leaving all in complete working order.
- E. Provide factory fabricated (or as specified) carriers for all wall hung fixtures.
- F. All automatic or self-closing valves for faucets shall be adjusted in accordance with manufacturer's instructions and supervised as necessary by equipment supplier's representative at the request of the Architect or Engineer.
- G. Owner (or others) furnished equipment shall be connected with drains, traps, hot water, cold water and other services required for optimum operation. The Contractor shall obtain information from the Owner or his appointed representative for services required, or field verify specific requirements. The Contractor shall also, prior to bidding, verify what type of connecting material and trim the Contractor shall provide for Owner, or others, furnished equipment. Contractor shall furnish and install all P-traps required and it shall be his responsibility to furnish traps compatible with the tailpieces.

- H. All fixtures shall be thoroughly cleaned to the satisfaction of the Architect before acceptance of the work.
- J. Refer to Section 22 13 00, Building Soil and Waste System, for shower pan flashing specifications.

3.2 COOPERATION WITH OTHER TRADES

- A. The Contractor shall fully examine the drawings and specifications of other trades to become familiar with all conditions affecting the work and consult and cooperate with other Divisions for determining space requirements and clearances with respect to other equipment, hangers, piping, and conduit in the building. The Architect reserves the right to determine space priority in the event of interference between piping, conduit, and equipment of various trades. Construction operations shall proceed without harm to the Owner from interference, delay, or absence of coordination.
- B. If work is installed without coordinating with other trades, and such installation interferes with their installation or proper clearances around equipment is not maintained, then make changes to correct the conditions without extra cost.
- C. The Contractor shall be responsible for the size and accuracy of all openings.

3.3 INTERRUPTING SERVICES

- A. The Contractor shall coordinate the installation of all work within the building in order to minimize interference with the operation of existing plumbing and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted to the Architect in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written approval of the Architect.

3.4 INVESTIGATION OF CONDITIONS

- A. Examine the drawings and all available information concerning existing installation, structure, excavations, and local conditions bearing on labor, transportation, handling and storage of materials, etc. Visit the site to understand the nature and the scope of all work to be performed and verify existing conditions shown on the drawings. The submission of a bid will be taken as evidence that such an examination has been made and all conditions have been considered and verified.

3.5 DRAWINGS

- A. The plumbing drawings show the general arrangement of all piping, ductwork, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. The Architectural and Structural Drawings shall be considered as part of the work insofar as this information furnishes the Contractor with details relating to design and construction of the building. Architectural drawings shall take precedence over the Plumbing drawings. Because of the small scale of the Plumbing Drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. Should conditions necessitate a rearrangement of piping, such departures and the reasons therefor shall be submitted by the Contractor to the Architect for approval in the form of detailed drawings

3.6 FIELD MEASUREMENTS

- A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for efficiency, and shall report any work which must be corrected. Coordination of all Plumbing work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the Plumbing work within the available space. No waiver of responsibility for defective work shall be claimed or allowed due to failure to report unfavorable conditions affecting his work. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor with all building trades. Installation of Plumbing equipment within the ceiling cavity shall be in the following order of priority:

1. Plumbing soil, waste and roof drain lines.
2. Supply, return and exhaust ductwork.
3. Steam and condensate piping.
4. Heating hot water and chilled water piping.
5. Lighting, bus duct and electrical cable trays.
6. Fire sprinkler mains.
7. Domestic hot and cold water mains.
8. Vent piping (for waste system).
9. Fire sprinkler branch piping.
10. Domestic hot and cold water branch piping.
11. Special piping systems (such as medical gas piping).
12. Pneumatic control piping.

3.7 HANGERS, SUPPORTS, AND INSERTS

- A. Contractor shall provide support for all equipment, piping, and ductwork to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of plumbing equipment and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify with the Architect that the devices and supports are adequate as intended and do not overload the building's structural components in any way.
- B. Keep piping in proper alignment and prevent transmission of thrusts and vibrations. Hangers and supports shall be capable of screw adjustment after piping is installed. Hangers shall be finely adjusted in vertical and horizontal direction under operating conditions.

3.8 PIPING AND DUCTWORK SEALANT THROUGH WALLS

- A. Sealant shall be capable of sealing pipe and conduit openings to restore fire and smoke rated walls and floors to their rated integrity. Sealant shall be UL classified. All penetrations in fire and smoke rated wall or floor assemblies shall be closed with 3M, or accepted equivalent, fire barrier penetration sealing systems and installed in accordance with the terms of their U.L. listing.

3.9 PROTECTION OF MATERIALS AND EQUIPMENT

- A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.
- B. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be accepted by the Architect prior to such storage.
- C. Pipe openings shall be closed with caps or plugs to prevent lodgement of dirt or trash during the course of installation.

- D. Plumbing fixtures shall not be used by the construction forces. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect.

3.10 TRENCHING AND BACKFILLING

- A. All excavation, trenching and backfilling required for the Plumbing installation shall be provided by this Contractor. Excavation and backfilling shall be done in strict accordance with Division 2, Site Work and Section 22 01 20.

3.11 MANUFACTURER'S INSTRUCTIONS

- A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Architect who shall make such compromises as he deems necessary and desirable.

3.12 BASES

- A. Support equipment and other Plumbing items on curbs, legs, concrete pads, or steel framework. Provide all curbs, bases, and supports not part of the building structure, unless indicated to be part of another Division. Furnish required foundation sizes, bolts, washers, sleeves, plates, templates, etc. for Plumbing equipment provided. Equipment shall be set level.
- B. All concrete inertia bases shown and/or detailed on the Plumbing plans will be furnished and installed under this section of the specifications and shall conform to the requirements specified under the Division 3 - Concrete, portions of these specifications. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all vibration isolators, anchor bolts, etc.
- C. Housekeeping pad foundations for floor mounted equipment will be installed under Division 3 - Concrete of the specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with carborundum block after stripping forms. Tops shall be level. This Contractor will be responsible for location and size of housekeeping pads for all Plumbing equipment.
- D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.
- E. Machinery bases, bed plates, sole plates, or vibration isolation units shall be carefully aligned, shimmed, leveled, then grouted in place with commercial non-shrink grout. When a flexible coupling is employed as a part of the drive train, the coupling shall be aligned before the machinery base is grouted.

3.13 EQUIPMENT FURNISHED BY OTHERS

- A. Certain items of equipment as listed on the drawings and/or specifications will be furnished by other Contractors or the Owner. This Contractor shall connect such equipment with utilities or ductwork to provide for proper operation in accordance with manufacturer's instructions.

3.14 LUBRICATION

- A. The Contractor shall provide all lubricants for the operation of all equipment until acceptance. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. The Contractor shall protect all bearings and shafts during installation.

3.15 TESTS

- A. All tests shall be conducted in the presence of the Owner's Representative. The Contractor shall notify the Architect one week in advance of all tests. Contractor shall make all necessary preliminary tests to ensure a tight system. Any joint found leaking under test shall be broken, cleaned, remade, and a new test applied. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.16 INSTALLATION CHECK

- A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Architect.
- B. Each equipment supplier's representative shall furnish to the Architect a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.
- C. Equipment requiring installation check includes, but is not limited to the following:
 - 1. Water Softener
 - 2. Domestic Hot Water Heaters
 - 3. Pumps
 - 4. Pressure Reducing Stations
 - 5. Sump Pumps

3.17 OPERATIONAL TEST

- A. After completion of testing, adjusting and balancing work, Contractor shall make an operating test covering all equipment furnished and installed under Divisions 22. This test shall cover a period of not less than 24 hours. The Contractor shall have all of his equipment operating and check all equipment for adjustments. The Contractor will instruct the Owner's operating personnel in the operation and maintenance of the systems in all specified modes.
- B. Operational test shall be conducted by the Contractor. Test shall be conducted in the presence of the Owner's Representative.

3.8 WARRANTY SERVICE

- A. Equipment items so noted will require factory authorized service personnel who shall provide all service, including all parts and all labor, as requested by the Owner during the full period of equipment warranty.

END OF SECTION

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SECTION 22 01 20

TRENCHING & BACKFILL FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and the General Requirements

1.2 SCOPE OF WORK

- A. The work in this section includes the furnishing of all labor, materials, equipment, transportation, hauling and services required in connection with the excavation, backfilling, compaction, grading and removal of earth from the site required for the installation of the mechanical work specified herein under Divisions 22 and 23.

1.3 SAFETY REGULATIONS

- A. All work performed under this Section shall conform to the requirements of the General Conditions, Supplementary Conditions and Safety Requirements for this type of work.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 TRENCHING AND BACKFILLING FOR UTILITIES

- A. Contractor shall verify all existing grades, inverts, utilities, obstacles and topographical conditions prior to any trenching, excavation or underground installations. In event existing conditions are such as to prevent installations in accordance with Contract Documents, Contractor shall immediately notify Architect for decision. Architect's decision will be final and binding.
- B. Contractor shall provide and maintain warning barricades, flags, torches, etc., and shall conduct his work so as to create a minimum amount of inconvenience to others, traffic, construction and the like. Temporary suspension of work does not relieve the Contractor of responsibility for the above requirements.
- C. All trenches shall be kept away from footings a minimum of 1' horizontal for each foot of depth below nearest footing or trench shall be filled with concrete to an elevation such as to establish the required one-for-one ratio of proximity.
- D. General Excavation: The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or with the top of piping not less than 24" below finished grade or not less than 6" below the frost line, whichever is greater.. During excavation, material shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated material not required or suitable for backfill shall be removed and wasted as indicated on the drawings or as directed by the Architect. Berming and grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations and any water accumulating therein shall be removed by pumping or by other accepted methods. Sheet piling and shoring shall be done as required for the protection of the work and for the safety of personnel.

- E. Trench Excavation: Trenches shall be of adequate width for the proper laying of the pipe, and the banks shall be as nearly vertical as practicable and safe for workmen. Bottom of trenches shall be excavated a minimum of 6 inches below bottom of pipe. Bedding material shall be native soil and shall be hand tamped in 6 inch layers. Bell holes and depressions for joints shall be dug after the trench bottom has been graded, and bedded in order that the pipe rests upon the prepared bottom for as nearly its full length as practicable. Care shall be taken not to excavate below the depths indicated. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 4 inches below the trench depths indicated on the drawings or specified.
- F. All below grade sewer piping shall have installed top of pipe elevations established at fifty (50) foot intervals witnessed by the Architect and recorded on the as-built drawing. All below grade piping installed within the building shall be dimensionally located from column lines and recorded on the as-built drawings.
- G. The Contractor shall move trucks and equipment on prescribed roads and keep the roads free from mud, dirt and spillage.
- H. If additional material is needed for fill on the project, it shall be furnished by the Contractor.
- J. Bracing and Bulkheading: In all excavation work the Contractor shall provide necessary underpinning, bracing, or bulkheading to safeguard the work, the present structures, workmen, the public, and the property, and shall assume all responsibility in connection therewith.
- K. Backfilling: The trenches shall not be backfilled until all required pressure tests are performed and until the utilities as installed conform to the requirements specified.
- L. Fill material shall be free from trash, lumber or any type of debris which may be detrimental to producing the required density in the fill.
- M. Optimum moisture content shall be maintained within 2% of the optimum moisture content at all times (Reference Soils Report). If the material is too dry, then water shall be added until the above moisture limits are reached. If the material is too wet, then it shall be mixed and blended with dry material or dried until the above moisture limit is reached.
- N. All piping not encased in concrete shall be bedded in sand or fine gravel, without rocks or other foreign material. Bedding material shall be placed around the pipe for the full width of the trench and shall extend at least 12" completely around chilled water cast iron pipe and 6" around all other piping directly buried. The bedding material shall be distributed around pipe to assure full consolidation.
- O. In grass and planted areas, the Contractor shall backfill his excavation to 8" below finished grade. Final 8" of backfill and all surface finish work will be done under Division 2.
- P. The Contractor shall protect from damage all existing underground utilities and utility tunnels indicated on the Contract Drawings (or field located for the Contractor by the Owner prior to excavation operations). Any damage to such existing utilities or utility tunnels shall be repaired by the Contractor without additional costs to the Owner.
- Q. Compaction density tests of trenching backfill are to be conducted as specified in Division 2. Costs for testing will be paid Owner. Re-tests of failed areas shall be paid for by the Contractor.

END OF SECTION

SECTION 22 05 19

PLUMBING PIPING SPECIALTIES

PART 1- GENERAL

1.1 REQUIREMENTS

- A. Contractor shall furnish and install all piping specialties necessary for satisfactory operation of the systems. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

1.2 RELATED SECTIONS

- A. See Section 22 01 00 for General Plumbing Requirements.
- B. Contractor shall furnish complete submittal data for all piping specialties, including manufacturer's specifications, class, type, catalog data sheets, etc.

PART 2 - PRODUCTS

2.1 STRAINERS

- A. Strainers shall be Sarco Type SB, or accepted equivalent by Keckley, Crane, Mueller, Wheatley or Fisher. Screens shall have 1/8" perforations for water service and 1/16" perforations for steam service. Every strainer shall be provided with a blow-off valve full size of strainer trapping. Before acceptance of the project, each strainer screen shall be removed and cleaned.

2.2 PRESSURE GAUGES

- A. Pressure gauges shall be Marshall town "Permagage", Ashcroft "Duragage", Weiss 4UGN-1, Trerice No. 500X or 601, Duro 105, Winter, or accepted equivalent. Dials shall be 4-1/2" unless otherwise noted. Provide Crane No. 88 or accepted equivalent needle valve for each gauge and syphon for each steam gauge. Select gauge so that operating pressure is near the midpoint of the scale. Mount gauges so that they are easily readable while standing on the floor.

2.3 THERMOMETERS AND THERMOMETER WELLS

- A. Furnish Moeller, Trerice, Jay Weksler, Albert Weiss Co., Duro, Winter, or accepted equivalent 7-inch scale red reading thermometer with separable socket and expansion heads. Thermometer wells shall be equivalent to H.O. Trerice No. 5572.
- B. Thermometers shall be easily readable from ground level. Where vari-angle thermometers are required for this purpose, use Trerice BX914 - 9" adjust angle, or accepted equivalent.

2.4 WATER REDUCED PRESSURE BACKFLOW PREVENTER

- A. Furnish and install water reduced pressure backflow preventers, as approved and accepted by the City of Colorado Springs, State of Colorado, Febco model 825Y, Conbraco 40 Series or equivalent. 3/4" minimum size shall be provided for water make-up to all hydronic systems. Backflow preventers shall be provided at other locations as shown on the drawings. Reduced pressure backflow preventers shall include two shut-off gate or ball valves, two check valves, pressure relief valve, and four test cocks. Units shall be factory assembled, tested, and certified. Units 2" and smaller shall be brass body, threaded connections, 175 psig maximum working pressure. Units 2-1/2" and larger shall be provided with flanged connections.

- B. Water reduced pressure backflow preventers installation shall be in accordance with the manufacturer's instructions and City of Colorado Springs, State of Colorado, requirements for access for testing and inspection.
- C. See Specification Section for Outside Utilities, for backflow protection associated with site water supply system.
- D. See Specification Section 22 11 00, Building Water Supply System, for backflow protection associated with building domestic water supply system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All specialties shall be installed in accordance with the best standard practices and as recommended by the manufacturer.
- B. Where thermometers or test fittings occur in insulation piping systems or on insulated equipment, extension necks shall be provided to extend beyond the insulation.
- C. Manual air vents shall be installed at the high points in all heating and cooling piping systems, whether shown on the drawings or not.
- D. Automatic air vents shall be installed at locations indicated on the drawings. Automatic air vents shall be installed level and in accordance with manufacturer's directions, complete with individual isolation valves.

3.2 STRAINERS

- A. All strainer screens, including basket strainers and suction diffusers, shall be removed and cleaned prior to commencing testing and balancing work and shall be maintained clean through the project final acceptance by the Owner. Suction diffuser start-up strainers shall be removed prior to final testing and balancing.

3.3 TEST AND ADJUSTMENT

- A. Contractor shall field adjust all water pressure regulating valves and specialties to provide required system operation.
- B. Contractor shall field test and verify the operation of all safety devices including water relief valves and temperature and pressure relief valves.

3.4 RELIEF VALVE DISCHARGE

- A. Water pressure relief valve and water temperature and pressure relief valve discharges shall be piped full size to the outside of the building or discharged indirectly in a properly sized building floor drain or floor sink as approved by the Architect and allowed by the Building Mechanical and Plumbing Codes. When the operating discharge temperature is in the excess of 212 degrees F, the discharge shall be equipped with a splash shield or centrifugal separator.
- B. Water reduced pressure backflow preventer discharge shall be piped full size to the outside of the building or discharged indirectly in a properly sized building floor drain or floor sink as approved by the Architect and allowed by the Building Mechanical and Plumbing Codes. Provide a bronze air gap funnel with stainless steel fasteners for installation under reduced pressure backflow preventer relief valve. Febco Model AGD or equivalent, 1" discharge pipe size for backflow preventer through size 2".

END OF SECTION

SECTION 22 05 23

VALVES

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.
- B. Lead Ban: Valves used in the installation of piping systems delivering water for human consumption shall be lead free. The term lead free is defined as valves which do not contain more than 8.0% lead.

1.2 RELATED SECTIONS

- A. See Section 22 01 00 for general plumbing requirements.
- B. See Section 22 20 00 for pipe fittings.

1.3 SCOPE

- A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems. All valves are to be of domestic manufacture only.
- B. Contractor shall submit complete submittal data, See Section 22 01 00, for all valves including manufacturer's specifications, class type, catalog data sheets, etc..

1.4 VALVE REQUIREMENTS

- A. All valves except lubricated plug valves and butterfly valves shall be manufactured by Milwaukee, Crane, NIBCO, Kennedy, Stockham, Walworth, Powell, Watts, Hammond, Conbraco, or accepted equivalent.
- B. Valves installed in insulated piping systems shall be furnished with valve stem extensions.

PART 2 - PRODUCTS

2.1 BALL VALVES

- A. Ball valves shall be cast of ASTM B-62 or B-584 bronze, 600 lb. W.O.G. 150 lb. WSP, chrome plated ball, full port, blow-out proof, threaded gland follower, reinforced Teflon seats, N.A. packing, full port type. NIBCO T-585-70 threaded, S585-70 soldered, or Apollo 77-100 threaded, 77-200 soldered, or Watts B-6080 threaded, B6081 soldered.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.
- B. Gate and globe valves shall be installed with stems above horizontal.
- C. Valves installed on insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.
- B. See Section 22 01 00 for general requirements.

1.2 SCOPE

- A. Domestic hot water pipe including circulating hot water.

1.3 TESTING

- A. All piping shall be tested and accepted before any insulation is applied.

1.4 FITTINGS

- A. All fittings except as otherwise specified, shall be insulated with the same material and thickness as specified for the pipe.
- B. Unions, flanges and valves on hot water, will not require insulation.

1.5 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer - Company specializing in manufacturing products specified with a minimum 5 years documented experience.
 - 2. Installer - Company specializing in performing the work of this section with a minimum 5 years documented experience.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Insulation shall be as manufactured by Owens-Corning Fiberglass, Gustin-Bacon, Johns-Manville, Armstrong, Manson, or accepted equivalent, and shall be equivalent to that specified below.
- B. Insulation and all materials on the interior and exterior surfaces of pipes, and equipment shall have a composite fire and smoke hazard rating not exceeding: Flame spread - 25; fuel contribution - 50; smoke developed - 50, as determined in accordance with ASTM Standard E-84. Linings in ducts, plenums, and equipment shall meet the Erosion Test Method described in Underwriter's Laboratory Publication No. 181. Insulation shall have a "k" factor of 0.23 at 75 deg. F mean temperature unless otherwise indicated. All insulation materials used for valves and fittings shall have the same ratings as the insulation. Information must be submitted to Architect by means of manufacturer's literature showing that the materials conform to above specification without exception.

2.2 FITTINGS

- A. Fittings, where required to be insulated, shall be covered with fitting mastic reinforced with fiberglass fitting tape and finished to a smooth surface or prefabricated or molded insulation may be used on all fittings where applicable, providing materials meet specified fire and smoke hazard ratings.

2.3 PVC FITTING COVERS

- A. PVC fitting covers may be used for all valves and fittings requiring insulation provided the materials used meet the fire and smoke hazard ratings specified above, and only where the valves and fittings have been wrapped with fiberglass blanket insulation of the same thickness of insulation used on the pipe. Fiberglass blanket shall be held in place with soft copper wire and adhesive applied to the valve or fitting.

PART 3 - EXECUTION

3.1 DOMESTIC HOT WATER PIPING

- A. Domestic hot water piping including recirculating piping shall be insulated with a minimum 1-inch thick Fiberglass one-piece preformed pipe insulation with all purpose (ASJ) fire retardant jacket. Refer to plans for required thickness based on pipe size. Fittings shall be finished with fittings mastic reinforced with Fiberglass fitting tape and finished to a smooth surface. Hangers shall be installed under the insulation.

3.2 INSULATION AT VALVES

- A. The termination of all insulation on pipes at valve connections or unions, etc., shall be beveled and finished same as called for on all fittings.

3.3 FACTORY INSULATED EQUIPMENT

- A. Domestic hot water heaters shall be factory insulated.

3.4 APPLICATION

- A. No pipe insulation shall be applied until piping has been pressure tested and accepted. No duct insulation shall be applied until the ducts have been inspected and accepted. All insulation shall be applied in strict accordance with the manufacturer's recommendations.

3.5 PIPE HANGERS

- A. Hangers for copper tubing shall be insulated from the tubing or hangers shall be of copper construction.

END OF SECTION

SECTION 22 11 00

BUILDING WATER SUPPLY SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with the applicable provisions of the General Conditions, Special Conditions, and the General Requirements.

1.2 RELATED SECTIONS

- A. See Section 22 01 00, General Plumbing Requirements.
- B. See Section 22 05 23, Valves.
- C. See Section 22 13 00, Building Soil and Waste System.
- D. See Section 22 20 00, Pipe & Pipe Fittings

1.3 SCOPE

- A. A complete domestic cold water, hot water, recirculating hot water, and make-up water system including water heater, pumps, shock absorbers, and associated miscellaneous items. This section is limited to the items referenced herewith within the building envelope and out to a point 5'-0" outside the building, unless noted otherwise on the drawings.
- B. Furnish and install all concrete, grout, and other required materials, to fill all blockouts and/or sleeves left open for the Contractor's convenience, or for the installation of this work.
- C. The work included in this contract consists of furnishing all labor, materials, equipment, tools and services; and includes all costs of permits and all costs whatsoever which may be required to completely install and place in operation the systems herein described.
- D. Equipment and Fixture Connections: The Contractor shall be responsible for rough-in and connection to equipment furnished by the Owner, by others, or as under the EQUIPMENT Sections of this specification. This shall include any equipment requiring connection, to domestic hot or cold water systems, direct or indirect waste, or vent piping as shown on the Architectural, Plumbing or Mechanical Drawings. The Contractor shall coordinate his rough-in work with the supplier of the equipment actually being furnished and shall conform to the service requirements of the furnished equipment. All final connections required by such equipment shall be made and tested by the Contractor. Carefully review the Architectural drawings for all of the equipment and fixture locations.

1.4 QUALITY ASSURANCE

- A. All pipe and fittings shall be of domestic (U.S.) origin.

PART 2 - PRODUCTS

2.1 PIPING

- A. Domestic water system piping below grade or slab on grade shall be Type "K" soft temper copper tubing.
- B. Domestic water system piping above slab on grade shall be Type "L" hard drawn copper tubing.

2.2 FITTINGS

- A. Fittings for copper piping below grade with brazed joints shall be wrought copper (the same thickness as the piping) for solder joint-pressure type.
- B. Fittings for copper piping above grade shall be wrought copper or cast red brass for solder joint-pressure type.

2.3 JOINTS

- A. Joints for copper piping systems 2" and smaller shall be made using 95-5 Tin-Antimony or approved lead free solder. (No 50/50 or any lead containing solder will be permitted on domestic water piping, hot or cold.)
- B. Joints for copper piping systems 2-1/2" and larger above grade slab and all sizes below grade slab shall be made using Sil-Fos, Easy Flow, or Phos Copper brazing rods with a melting temperature above 1000 deg. F.

2.4 PROTECTION OF PIPING

- A. Copper piping installed below grade or slab on grade shall be protected against corrosion as follows:
 - 1. One and one half inch (1-1/2") or smaller shall be installed in polyethylene protective conduit terminated not less than 6" above finished floor slab and a minimum 36" from the building outside wall.
 - 2. Two inch (2") or larger shall be protected by a double wrapping of X-Tru-Coat, or Scotch Wrap, or by a double coat of bituminous paint. Termination of coating shall be the same as described for 1-1/2" or small pipes.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPING

- A. All water piping shall be run free from traps and arranged so that all parts of the system can be drained. Provide accessible 3/4" gate valves with hose ends where required for this purpose. Provide expansion loops or connections throughout the system to allow for adequate horizontal and vertical expansion and contraction, and for building settling at the point of water main entry into the building. All pipe size changes shall be made with reducing fittings or bell reducers or increasers where any change in the pipe sizes occur. No bushing of any nature shall be allowed in piping.
- B. Care shall be taken to avoid mechanical ductwork, electrical equipment and air handling equipment above ceiling. The Contractor shall be responsible for coordinating routing of piping with ceiling Contractor and sheet metal Contractor. Relocation of piping required from poor coordination by the Contractor shall be at his own expense.
- C. No water piping shall be located in outside walls unless shown, and then piping is to be insulated and located as close as possible to inside of wall cavity with additional insulation between piping and exterior of wall.
- D. Written prior approval required for all proposed substitutions of equipment and materials, 10 days prior to bid date of project.
- E. All piping shall be concealed where possible. All exposed piping where concealment is not possible, or in equipment room, shall be painted.
- F. All trenching and backfill for piping shall be the responsibility of the Contractor.

- G. Any changes to the plans shall be accepted by Architect/Engineer. Contractor shall submit in writing any proposed changes for approval and receive approval prior to making such changes.
- H. All pipe through footings below floor slab shall have cast iron soil pipe sleeve (minimum two pipe sizes larger) which extends full width of footings.
- K. No existing water lines located below the floor slab shall be reused as part of new system, unless specifically noted and permitted on drawings.
- L. All pressure and temperature relief valves shall have adjacent unions and shall be piped separately to nearest floor drain or outside.
- M. Pipe openings shall be closed with caps or plugs to prevent lodgement of dirt or trash during the course of installation.

3.2 VALVE CONTROL

- A. Control valves shall be installed where shown on the plans and/or as directed, wherever necessary for controlling the several sections of the domestic water system. All valves shall have adjacent unions (except on copper piping.) Valves shall be provided on all inlet connections to all kinds of apparatus, all risers and all groups of fixtures. Groups of fixtures shall be arranged to have their group valves in one location. Access shall be provided to all concealed valves by means of access doors furnished by the Contractor and installed by the Contractor. The Contractor shall coordinate the location of valves with architectural features of the building in order that the access doors will be located symmetrically with the other features.

3.3 VALVES

- A. All ball valves shall be designed for repacking under pressure when fully opened and shall be equipped with packing suitable for the intended service. Gate valves shall be installed in the horizontal position, other valves in the vertical position and, whenever possible, shall be grouped.
- B. Valves shall be full port and manufactured by Jenkins, Nibco, Crane, Milwaukee, Walworth, Norris, Stockham, Kennedy, Lunkenheimer, Nordstrom, Dezurick or Grinnell and shall be as specified in Section 23 05 23.

3.4 UNIONS AND FLANGES

- A. Unions and flanges shall be installed at all points necessary to permit easy removal of valves and equipment without injury to other parts of the system. Unions in screwed piping shall be Grinnell Fig. 459. Unions in copper piping shall be Grinnell Fig. 9102 in wrought copper, Fig. 9730 in cast brass. Fabricate flanged headers to make it possible to remove tube bundles, or similar items, without having to disconnect any major portions of piping.
- B. All connections between ferrous and non-ferrous piping or equipment shall be made with dielectric unions. Dielectric material shall not be paper.

3.5 HYDRANTS AND HOSE BIBBS

- A. Hose bibbs, wall and box hydrants shall be the type as specified in the Plumbing fixtures, trim and equipment specifications as shown on the drawings. Deliver all hydrant keys and handles to the Owner's representative.
- B. All hose bibbs and hydrants shall have a vacuum breaker on the outlet. Install a shutoff valve before hose bibb/wall hydrant/ground hydrant for maintenance purposes.

3.6 GAUGES AND THERMOMETERS

- A. Furnish and install pressure gauges and thermometers where shown on plans or are called for and shall be as specified in Section 22 05 19.

3.7 ACCESS DOORS

- A. All concealed valves, controls, etc., shall be provided with access doors. Type of doors as specified in the Specification Section 22 01 00.

3.8 TESTS

- A. Test water pipe systems at 100 psi minimum in the presence of the General Contractor or Architect and prove water to be tight. Use higher pressure when indicated, or where required for building height or by Authority Having Jurisdiction.

3.9 STERILIZATION

- A. On the building side of the water supply piping, provide a 3/4 inch connection through which chlorine shall be introduced into the building water piping systems to sterilize those systems thoroughly.
- B. After completion of testing, the entire cold and hot water piping systems, with attached equipment, shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine, or calcium hypochlorite or chlorinated lime, and shall be pumped into the system through the connection described above. The sterilization solution shall be allowed to remain in the system for a period of twenty-four (24) hours during which time, all valves and faucets shall be opened and closed several times. After sterilization, the solution shall be flushed from the system with clean water until the residual chlorine content is not greater than 0.2 parts per million.
- C. The sterilization process shall be conducted as described by the State of CO., Department of Public Health, and upon completion of the process, the Testing Agency shall test and certify the cleanliness of the water piping system. The Contractor shall pay all costs and charges incidental to this test.

END OF SECTION

SECTION 22 13 00

BUILDING SOIL AND WASTE SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Special Conditions, and General Requirements.

1.2 RELATED SECTIONS

- A. See Section 22 01 00, General Plumbing Requirements.
- B. See Section 22 05 23, Valves.
- C. See Section 22 07 00, Plumbing Systems Insulation.
- D. See Section 22 11 00, Building Water Supply System.
- D. See Section 22 20 00, Pipe and Pipe Fittings.

1.3 SCOPE

- A. The building sanitary drainage system limited to a point 5'-0" outside of the building (unless noted otherwise) shall be installed, as shown on the Plans, complete with all fixtures, drains, traps and required connections. All fixtures and drains shall be properly trapped and vented as required by the applicable plumbing code.
- B. Furnish and install all concrete, grout, and other required materials to fill all blockouts and/or sleeves left open for the Contractor's convenience, or for the installation of this work.
- C. The work included in this contract consists of furnishing all labor, materials, equipment, tools and services, and includes all costs of permits and all costs whatsoever which may be required to completely install and place in operation the systems herein described.
- D. Equipment and Fixture Connections: The Contractor shall be responsible for rough-in and connection to equipment furnished by the Owner, by others,. This shall include any equipment requiring connection to domestic hot or cold water systems, direct or indirect waste, or vent piping as shown on the Architectural Plumbing or Mechanical drawings. The Contractor shall coordinate his rough-in work with the Supplier of the equipment actually being furnished and shall conform to the service requirements of the furnished equipment. All final connections required by such equipment shall be made and tested by the Contractor. Carefully review the Architectural drawings for all of the equipment and fixture locations.

1.4 QUALITY ASSURANCE

- A. All pipe and fittings shall be of domestic (U.S.) origin.

PART 2 - PRODUCTS

2.1 PIPING

- A. Soil, waste, and vent piping below slab on grade shall be polyvinylchloride (PVC) sewer pipe, Schedule 40, conforming to ASTM D2665, D3311, and D1784.
- B. Soil, waste, and vent piping above grade shall be hubless cast iron soil pipe and fittings conforming to ASTM Standard A-888 and/or CISPI Standard 301 (latest revision) and Federal Specifications WW-P-401E(Type III).

2.2 FITTINGS

- A. Fittings for cast iron sanitary soil, waste and vent piping system shall be service weight cast iron drainage pattern conforming to CISPI Standard 301-95, coated for underground installation. Threaded cast iron drainage pattern fittings to conform to ANSI Standard B-16.4. Fittings shall be provided to match the required piping system.
- B. Fittings for PVC piping system shall be Schedule 40 drainage pattern, solvent cement type conforming to ASTM B-2855 or elastomeric seal type conforming to ASTM D-3212.
- C. Tapped sanitary tees and crosses will be permitted only for fixtures connections. Crosses shall have the barrel of the fitting two pipe sizes larger than the largest branch inlet.
- D. Vent fittings installed below slab on grade shall have drainage pattern.

2.3 JOINTS

- A. Joints on cast iron soil waste and vent system below grade slab shall be gaskets conforming strictly to ASTM Standard C564, latest issue or no-hub sealing sleeves conforming strictly to ASTM Standard C564, CISPI Standard 310 (latest revision), ASTM C1277, and Federal Specifications WW-P-401.
- B. Joints on cast iron soil waste and vent system above grade slab shall be no-hub sealing sleeves conforming strictly to ASTM Standard C564, CISPI Standard 310 (latest revision), ASTM C1277, and Federal Specifications WW-P-401.
- C. Joints for PVC piping system shall be either solvent cement type conforming to ASTM D-2855 or elastomeric seal type conforming to ASTM D-3212, except all joints above grade shall be solvent cement.

2.4 EQUIPMENT DRAINS

- A. The Contractor shall extend drain lines from all equipment requiring drainage, relief valves, reduced pressure backflow preventers, and drain pans to the nearest floor drain or floor sink, or as shown on the drawings, or as directed by the Engineer.
- B. Relief valve drain lines shall be equal in size to the valve outlet port and shall be sloped away from the relief valve.
- C. Equipment drain lines shall be Type "M" copper tubing with solder fittings.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING

- A. The Contractor shall promptly install sewer, drains, and piping after excavating, chasing or cutting for same as has been done, so as to keep the openings for such piping open as short a time as possible. No piping shall, however, be permanently closed up, furred in or covered before the testing and examination of same by the authorities having jurisdiction.
- B. All piping shall be run in the most direct manner. Horizontal pipe shall have a grade of one-quarter (1/4) inch per foot wherever possible and not less, in any case, than one-eighth (1/8) inch per foot (1/8" per foot allowable only for pipes 4" in diameter and larger). All offsets shall be 45-deg. or less.
- C. Cleanouts shall be provided at:
 - 1. The bottom of each soil or waste stack;
 - 2. On horizontal drain lines below grade longer than 5';
 - 3. On each plumbing fixture or group of fixtures;
 - 4. On horizontal vent lines if rising at an angle less than forty-five (45) degrees from the horizontal up to a point at least six inches (6") above the flood rim of the fixture served by the vent;
 - 5. At each change of direction which exceeds a total of 45 degrees;
 - 6. On interior horizontal runs below grade at intervals not exceeding 95';
 - 7. On exterior horizontal runs at intervals not exceeding 100', as shown on the drawings, and as required by the plumbing code.
 - 8. Two-way cleanouts outside of the building shall be installed as shown on the drawings, or as a substitution for an upper terminal cleanout.
 - 9. All interior cleanouts shall be the same size as the pipe served up to 4" size and 4" for all larger lines. Exterior cleanouts shall consist of a concrete encased wye in the line with sewer piping extending upward therefrom and terminating in a concrete slab at grade. A cleanout casting as specified shall be set on this slab in such a manner as to be flush with the finished grade. All exterior cleanouts shall be the same size as the sewer up to 6" size and shall be 6" for all larger lines. See Cleanout details and Specifications.
- D. Fixture vent piping shall be kept above the fixtures in such a manner as to preclude the use of the vents as waste, if the waste pipes later become obstructed. All vent pipes shall be properly graded without drops or sags, and so connected as to drip back to waste pipes by gravity. Whenever practical, or as shown on the drawings, two or more vents shall be connected together at a point not less than 6" above flood rim of fixtures served by the vent, and extended as one vent through the roof. Vent piping installed below grade slab shall be not less than 2" diameter.

3.2 FLASHINGS

- A. Flash vent piping through roof (V.T.R.) with lead flashing, weight of not less than four (4) pounds per square foot, extending at least 14" in all directions under roofing and 12" up around the vent pipe. Cap flash pipe and turn down inside 1" approximately. Install all vent pipes extending through roof prior to roof installation. Flashing shall be two-piece type, base and cap flashing. Prior to the roofing installation, furnish base flashing pieces to the Contractor for installation by the Contractor. The Contractor shall install cap flashing.
- B. Floor drains and floor sinks (which are specified with a flashing clamp) and all job-site built shower pans shall be flashed with 0.40" thick non-plasticized chlorinated polyethylene sheet, Chloraloy 240, as manufactured by Noble Company, or accepted equivalent. Each floor drain and floor sink flashing shall be minimum 36" x 36" square and shall be terminated (if applicable, in corners and against walls) not less than 6" above finish floor.
- C. Lead flashing of floor drains, floor sinks and shower pans will not be permitted.

3.3 FLOOR DRAIN AND FLOOR SINKS

- A. Floor drains and sinks shall be as manufactured by Smith, Wade, Josam or Zurn. Provide flashing clamp devices and flashing where required by floor construction and where specified.
- B. See Plumbing Equipment Specifications Section 15450 for types. All floor drains and sinks shall be installed with grates square with building lines.

3.4 TESTS

- A. The Plumbing Contractor shall be responsible for contacting the Authority Having Jurisdiction prior to the start of construction to verify the testing requirements.
- B. The Testing Agency shall certify in writing that all tests were satisfactorily completed before piping was concealed, and shall submit the certification to the Architect for his records, and for transmittal to the Owner.

END OF SECTION

SECTION 22 14 00

BUILDING ROOF DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with the applicable provisions of the General Conditions, Special Conditions, and the General Requirements.

1.2 RELATED SECTIONS

- A. See Section 22 01 00, General Mechanical Requirements.
- C. See Section 22 20 00, Pipe and Pipe Fittings.
- D. See Division 7, Thermal & Moisture Protection.

1.3 SCOPE

- A. A complete storm water drainage piping system shall be installed as shown on the plans and shall be limited to a point 5'-0" outside of the building, unless otherwise noted.
- B. Complete overflow roof drainage system as shown on the plans .
- C. Roof and overflow drains shall be furnished and piped under Division 22 but installed under Division 7 of the Specifications.

1.4 QUALITY ASSURANCE

- A. All pipe and fittings shall be of domestic (U.S.) origin.

PART 2 - PRODUCTS

2.1 PIPING

- A. Roof drain piping below slab on grade shall be Polyvinylchloride (PVC) pipe, Schedule 40, conforming to ASTM D2665, D3311, and D1784.
- B. Roof drain piping above grade shall be hubless cast iron soil pipe and fittings conforming to ASTM Standard A-888 and/or CISPI Standard 301 (latest revision) and Federal Specifications WW-P-401E(Type III).
- C. Piping for pumped roof and area drainage systems from the discharge of the sump pumps to the connection to the gravity flow drainage system shall be schedule 40 galvanized steel or Type L hard drawn copper pipe for above ground installation. When underground piping is required within the building and to a point 5'-0" from the building perimeter, the underground piping shall be coated cast iron or ductile iron pressure pipe and fittings

2.2 FITTINGS

- A. Fittings for cast iron pipe shall be service weight cast iron drainage pattern, conforming to CISPI Standard 301-95 and ASTM A-888.
- B. Fittings for PVC piping system shall be Schedule 40 drainage pattern, solvent cement type conforming to ASTM B-2855 or elastomeric seal type conforming to ASTM D-3212.

2.3 JOINTS

- A. Joints on cast iron roof drain systems below grade slab shall be gaskets conforming strictly to ASTM Standard C564, latest issue. No hub couplings above and below ground, shall be multiple band type (4 bands = 1-1/2" thru 4") and (6 bands = 5" thru 10"). Contractor to follow the manufacturers recommendation on PSI of torque required to secure couplings. No-hub sealing sleeves conforming strictly to ASTM Standard C564, CISPI Standard 310 (latest revision), ASTM C1277, and Federal Specifications WW-P-401. Couplings shall be manufactured by Clamp All, Mission "Heavy Weight", Husky "2000" or Ideal Tridon "MD".
- B. Joints for PVC piping system shall be either solvent cement type conforming to ASTM D-2855 or elastomeric seal type conforming to ASTM D-3212, except all joints above grade shall be solvent cement.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING

- A. All piping shall be run in the most direct manner. Horizontal pipes shall have a grade of 1/4" per foot wherever possible and not less, in any case, than 1/8" per foot, unless shown otherwise on the plans. All offsets shall be 45 degrees or less.
- B. Size reduction of vertical R.D. leaders is not permitted.
- C. Roof drain leaders and or overflow leaders which extend below grade shall have a test tee installed above the finished grade. The test tee shall be installed for the testing of the below grade and above grade systems which require testing at different time throughout the construction process. Once approved by the local jurisdiction the test tees can be concealed within a wall or chase.

3.2 ROOF DRAINS

- A. All roof drains will be furnished and installed by the Contractor with all accessories required for the particular construction in which they are to be mounted, and shall be as manufactured by Smith, Mifab, Zurn or Wade.
- B. Roof drains shall be flashed with lead flashing, weight of not less than four (4) pounds per square foot or with laminated flashing, Nobleflex (0.40" thick non-plasticized chlorinated polyethylene sheet adhered with asphalt-saturated roofing felt), as manufactured by the Noble Company, or an accepted equivalent. Each flashing shall be a minimum of 36" x 36" square.

3.3 TESTS

- A. The Plumbing Contractor shall be responsible for contacting the Authority Having Jurisdiction prior to the start of construction to verify the testing requirements.
- B. The Testing Agency shall certify in writing that all tests were satisfactorily completed before piping was concealed, and shall submit the certification to the Architect for his records, and for transmittal to the Owner.
- C. Piping for pumped roof and area drainage systems shall be pressure tested as specified in Section 22 11 00 for water systems as a minimum pressure equal to the system working pressure.

END OF SECTION

SECTION 22 20 00

PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

1.2 RELATED SECTIONS

- A. See Section 22 01 22 for general plumbing requirements.

1.3 SUBMITTAL DATA

- A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, seismic restraints, pipe sleeves including sealing and fire safing materials and installation.

1.4 QUALITY ASSURANCE

- A. All pipe and fittings shall be of domestic (U.S.) origin.
- B. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

- A. Pipe and pipe fitting material requirements are specified under the sections covering the various piping systems.

2.2 FLOOR, WALL AND CEILING PLATES

- A. Where exposed pipes pass through finished floors, finished walls, or finished ceilings, they shall be fitted with chromium plated spun brass flanges. Plates shall be large enough to completely close the hole around the pipe, and shall not be less than 1-1/2" or more than 2-1/2" larger than the diameter of the pipes. All plates shall be securely held in place.

2.3 UNIONS AND FLANGES

- A. Piping 2-1/2" and larger to have bolted flange unions with gaskets of material suitable for the specified service. Flanges shall conform to Federal Specifications WW-F-406a, Class 125. Ground joint unions with brass to iron seats, conforming to Federal Specification WW-V-531c shall be used in piping 2" and smaller. Unions or flanges shall be installed at all valves and equipment connections.
- B. Unions and flanges for servicing and disconnect are not required in installations using grooved joint couplings. (The coupling shall serve as disconnect point.)

2.4 HANGERS AND ANCHORS

- A. All piping shall be rigidly supported from the building structure by means of vertically adjustable swivel ring clevis type hangers suspended on threaded steel rods. Where pipes run side by side, support on rod and angle iron, or unistrut, trapeze hangers. Cast iron soil waste and vent piping shall have hangers not more than one foot on each side of every change in direction and 2'-6" on each side of every change in direction for all other piping. Piping system shall be installed in an approved manner and shall not overload the building structural frame. Contractor shall provide additional hangers and steel members as may be required to distribute the piping system load over several structural members where required or directed. Ellen, Fee and Mason, Grinnell, Michigan, and Superior are acceptable manufacturers.

Maximum allowable spacing shall be as follows:

<u>Steel Piping</u>	-	<u>Maximum Spacing</u>
1/2"	-	6'-0"
3/4" through 1-1/4"	-	8'-0"
1-1/2" through 2-1/2"	-	10'-0"
3" through 12"	-	12'-0"
<u>Copper Piping</u>	-	<u>Maximum Spacing</u>
1/2"	-	6'-0"
3/4", 1"	-	8'-0"
1-1/4" through 2"	-	10'-0"
2-1/2" and above	-	12'-0"
<u>Cast Iron Piping</u>	-	<u>Maximum Spacing</u>
3"	-	1 ea. joint
4" and 5"	-	1 ea. joint
6"	-	1 ea. joint

The above spacing is the general case. Do not exceed the loading allowance on the structure. Reduce the hanger spacing in order to meet the loading allowance as required.

- B. Round rods supporting the pipe hangers shall be of the following dimensions:

<u>Steel Piping</u>	-	<u>Hanger Rod size</u>
1/2" through 2"	-	3/8"
2-1/2", 3"	-	1/2"
4", 5"	-	5/8"
6"	-	3/4"
8" through 12"	-	7/8"
<u>Copper Piping</u>	-	<u>Hanger Rod size</u>
1/2" through 2"	-	3/8"
2-1/2" through 5"	-	1/2"
6" and above	-	3/4"
<u>Cast Iron Piping</u>	-	<u>Hanger Rod size</u>
3"	-	1/2"
4" and 5"	-	5/8"
6"	-	3/4"

- C. Hangers for copper tubing shall be insulated from the tubing or hangers shall be of copper construction. Rods for trapeze hangers shall be a minimum of 3/4" and shall have the equivalent cross section listed above per pipe supported. The use of pipe hooks, chains, or perforated iron for pipe supports will not be permitted. Contractor shall provide a 8" long, 14 gauge galvanized steel protection saddle for all insulated pipes where pipe is resting on hangers, trapeze, unistrut, or other similar support structure. The Contractor shall provide inserts in the building construction at the time the concrete is poured, and the hangers shall be attached to these inserts. Where inserts cannot be used, expansion shields may be used provided the hanger is not attached rigidly to the bolt but is supported from an angle held in place by the expansion bolt. Anchors and guides shall be provided where required for proper control of expansion and contraction.
- D. Attachment of piping hangers to the building structure shall be provided in a manner accepted by the Architect and/or Structural Engineer. When hanging from steel structure, use concentrically loading beam clamps. The use of eccentrically loading "C" clamps is prohibited.

2.5 CONDENSATE DRAIN CONNECTION

- A. The Plumbing Contractor shall coordinate and install a tail piece with a condensate drain connection as required by the mechanical drawings for condensate piping which ties into a lavatory tail piece.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Provide and erect, in a workmanlike manner, according to the best practices of the trade, all piping shown on drawings and required for the complete installation of these systems. The piping shown on the drawings shall be considered as diagrammatic for clearness in indicating the general run and connections, and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of systems or piping in every respect suitable for the work intended as described in the specifications and accepted by the Architect. In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment or filters or devices; and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment including refrigeration machines. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated, packed and adjusted at the completion of the work before final acceptance. All piping shall be erected to ensure proper draining. Water piping may be run level but shall be free from traps.

3.2 JOINTS

- A. Solder Joints: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings shall be made with a noncorrosive paste flux and solid 95-5 wire solder, unless otherwise specified. Cored solder or any solder containing lead will not be permitted.
- B. Insulating Fittings: Insulating fitting shall be used to connect dissimilar metals (such as steel and copper) to prevent electrolytic action. Insulating fittings will not be required between bronze valves and steel pipe, or between copper coil headers and steel pipe.

3.3 PIPE SLEEVES

- A. Piping will not be permitted to pass through footings, beams or ribs except where written consent of the Architect. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through concrete or masonry construction and steel decks. Pipe sleeves shall be cast iron soil pipe and shall be of sufficient diameter to provide ½" minimum clearance around the pipe, and in cases of insulated pipes, 1/2" minimum around the insulation. Pipe sleeves in footings and beams shall be of steel pipe. Sleeves in footings shall be not less than 1" or more than 2" larger in diameter than the pipe to be installed. Pipe sleeves in floors shall extend 2" above finished floor in toilets or rooms where domestic water is used. Openings between piping sleeves shall be made watertight with plastic cement to a minimum depth of 2". In addition, openings between piping and sleeves in all masonry, concrete interior walls or gypboard fire walls and partitions shall be tightly sealed to prevent gases from passing through the pipe sleeves in the event of fire. Where pipes pass through exterior walls, the annular space between the wall and the pipe shall be sealed by sealing elements made of synthetic rubber, pressure plates, and cadmium plated bolts equivalent to Link- Seal LS-300 up to 10" pipe size larger than carrier line.

3.4 EXPANSION AND CONTRACTION

- A. For water systems, flexible couplings may be used on header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops (as approved by the engineer). Where loops are required, use flexible-type couplings on the loops.

3.5 PROTECTIVE COATINGS

- A. All underground steel pipe shall be wrapped with "Scotchwrap" No. 50 tape to give not less than two complete layers on the entire underground piping system, or piping shall have X-Tru-Coat factory applied plastic protective covering.

3.6 TESTING

- A. Before any insulation is installed or before piping is covered or enclosed, all piping systems shall be tested and proven tight at not less than the maximum service pressure which the piping systems will be required to handle, unless otherwise specified. All tests shall be witnessed and accepted by the Architect or his authorized representative.
- B. Tests shall not be used to establish pressure ratings.
- C. Protect all piping and equipment against overpressure, collapse from vacuum, and hydraulic shock during the filling, testing and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating.
- D. Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60°F. Note that some applicable codes may require testing above a specified minimum temperature.

- E. Remove from the system all pumps, turbines, traps, expansion joints, instruments, control valves, safety valves, rupture discs, orifice plates, etc., which might be damaged by the test, or are designated by the Engineer.

3.7 FLUSHING, DRAINING, AND CLEANING PIPE SYSTEMS

- A. The Contractor shall flush out all water systems with pre-start-up cleaner before placing them in operation to remove all oil and foreign material from piping and equipment. Other systems shall be cleaned by blowing them out with compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.
- B. Coordinate with the Plumbing Sub-contractor to supply sufficient pre-start-up cleaner for flushing and cleaning of systems to remove all oil and foreign matter from piping and equipment.
- C. This contractor shall clean all strainers after initial flush, after cleaning flush, and prior to start-up.

END OF SECTION

SECTION 22 61 00

COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, the Special Conditions and General Requirements.
- B. See Sections 22 01 00, 22 05 19, 22 05 23, and 22 20 00 for general mechanical requirements and related work.

PART 2 - PRODUCTS

2.1 AIR COMPRESSOR

- A. The air compressor is specified in the Equipment Schedule on the drawings.

2.2 PIPING

- A. Piping shall be Type L hard drawn copper tubing with solder type wrought copper fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractor shall be responsible for furnishing and installing the air compressor, piping, and all accessories required for a complete installation.
- B. All underground piping shall be protected against corrosion by wrapping or coating as specified in Section 22 20 00.

3.2 TESTING

- A. The entire compressed air system shall be tested at a pressure of 200 psig, and shall show no loss of pressure for two (2) hours. The Testing and Balancing Agency shall certify in writing that all tests were satisfactorily completed before the piping was concealed and shall submit the certification to the Architect.

END OF SECTION

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SECTION 23 01 00

GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. See General Conditions and Supplementary Conditions.
- B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all sections of Division 23 and form a part of the contract.

1.2 CODES AND PERMITS

- A. The mechanical work shall be performed in strict accordance with the applicable provisions of the International Building Code, International Mechanical Code, as adopted and interpreted by the State of Arizona, the Authority Having Jurisdiction, and the National Fire Protection Association (NFPA) Regulations, current adopted edition, regarding fire protection, plumbing systems, heating and ventilating and air conditioning systems and electrical systems. All materials and labor necessary to comply with rules, regulations and ordinances shall be provided. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Architect free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.
- B. Permits necessary for performance of the work shall be secured and paid for by the Contractor. All utility connections, extensions, meter pits and meter sets and tap fees for water, storm sewer, sanitary sewer and natural gas shall be paid for by the Contractor.

1.3 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall furnish the Architect complete operating and maintenance instructions covering all units of mechanical equipment herein specified together with parts lists. Furnish four (4) copies of all the literature; each shall be suitably bound in loose leaf book form.
- B. See Division 1 for additional requirements concerning manuals, manual distribution, and maintenance materials.
- C. Operating and maintenance manuals as required herein shall be submitted to the Architect for review and distribution to the Owner not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

1.4 RECORD DRAWINGS

- A. See Division 1 for requirements associated with Project Record Drawings.

1.5 QUALIFICATIONS

- A. All mechanics shall be skilled in their respective trades.

1.6 SUBMITTALS

- A. See Division 1 for additional submission requirements.
- B. The Contractor shall submit a minimum seven (7) copies of submittal brochures for review, or as indicated in Division 1. All but one of the copies will be returned with approval notations. Brochures shall be submitted within thirty (30) days after contract award.
- C. Submittals shall be bound, tabulated, and index. All submittals shall be submitted at one time. Partial submittals and unbound submittals shall be returned to the Contractor unreviewed for completion and resubmittal.
- D. Complete data must be furnished showing quality, dimensions, complete certified characteristics of equipment, capacity, code requirements, motor drives, and certified performance curves for all fans and pumps. No equipment or materials shall be purchased prior to receiving written notification from the Architect that submittals have been reviewed and marked as follows:
 - 1. REVIEWED - NO EXCEPTIONS (Contractor Resubmittal Not Required)
Reviewed manufacturer and equipment specifications. Appears to be in conformance with design drawings/specifications.
 - 2. REVIEWED - MAKE CORRECTIONS NOTED (Contractor Resubmittal Not Required)
Reviewed manufacturer and equipment specifications. Appears to be in conformance with design drawings/specifications. Minor adjustments required to the equipment options/accessories. Resubmittal not required if written acknowledgement is sent to the General Contractor and Architect that this items will be provided as corrected. Sub-contractor shall also provide final record submittal to the general contractor.
 - 3. REVIEWED - FOR RECORD ONLY (Contractor Resubmittal Not Required)
Reviewed only for coordination purpose only of another trade engineering submittals or contractor generated shop-drawings. (Often these are contractor generated installation drawings or 3rd party sealed design drawings (typically seismic engineering for MEP equipment/piping).
 - 4. REVISE & RESUBMIT (Contractor Resubmittal Required)
Specific manufacturer is acceptable. Equipment model, application, capacity, design parameters, code listing, testing listing is not acceptable or not provided. Resubmittal is required and all engineers' comments shall be addressed in summary memo attached with the resubmittal.
 - 5. REJECTED (Contractor Resubmittal Required)
Specific manufacturer is not acceptable and rejected. Manufacturer is not listed within project specs and was not prior approved within the timeframe required. Other model types/applications produced by the is manufacturer will not be accepted
- E. Review and Approval of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and with the information indicated on the Drawings and stated in the Specifications. Approval of a separate item as such will not indicate approval of the assembly in which the item functions. Approval of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the Contract Documents, nor shall approval relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including a minimum of 4 feet clear in front of all electrical control equipment and panels, for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the Work.
- F. Use of accepted substitutions does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from accepted substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

- G. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1'-0" fabrication drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1'-0" fabrication drawing shall be submitted and accepted by the Architect before construction begins.
- H. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior approval or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received written approval, removal of all the unauthorized materials and installation of those indicated or specified shall be provided at no extra cost to the Owner.
- J. Expense: All costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

1.7 PRIOR APPROVAL

- A. See Division 1 for substitutions and product options. In general, written requests must be received in the Architect's office ten (10) days prior to bid date to be considered. Verbal approvals will not be given.
- B. Requests for proposed substitutions shall be accompanied with catalog and technical data. Actual equipment components and options shall be highlighted and any discrepancies with the specified equipment noted.

1.8 IDENTIFICATION OF VALVES

- A. Each valve shall be provided with a tag secured to the valve with metal chain or copper wire. Tag shall indicate both the service and function of each valve. Contractor shall furnish two sets of prints of drawing and showing floor plan for each floor with all valves accurately located and labeled. Drawing shall be submitted to the Architect in accordance with the requirements specified under Paragraph "Operating and Maintenance Instructions" in this Section. These drawings shall be neat and easily read. Tags shall be stamped brass (1-1/2" or 2" diameter) with 1/4" high figures.

1.9 UNDERGROUND PIPING SYSTEM IDENTIFICATION

- A. All underground facilities shall be locatable above ground without potholing. "Underground Facility" means any item of personal property that is buried or placed below ground for use in connection with the storage or conveyance of water, sewage, oil, gas or other substances, and shall include but not be limited to pipes, sewers, valves, lines, manholes, etc., and landscape irrigation systems of two inches in diameter or less. Metallic gas service lines installed on private property by the utility company are detectable without the following requirements:
 - 1. All buried nonmetallic private water lines and nonmetallic fire lines shall have a blue #18 insulated tracer wire securely attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and be securely attached at that point.
 - 2. All buried nonmetallic private sewer lines shall have a green #18 insulated tracer wire attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and be securely attached at that point.
 - 3. All buried nonmetallic private gas line shall have a yellow #18 insulated tracer wire attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and securely attached at that point.
 - 4. All buried nonmetallic private landscape sprinkler lines greater than 2" in diameter shall have a purple #18 insulated tracer wire securely attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and be securely attached at that point.

- 5. All nonmetallic underground facilities including but not limited to mechanical, oil, chilled water, refrigerants, steam, or empty conduit shall have a white #18 insulated tracer wire attached to it at 8' o.c. and shall have 12" of tracer wire accessible above grade at the termination and be securely attached at that point.
- B. Where an installation of any of the above referenced items connects to a public utilities service facility that does not re-emerge above grade the tracer wire shall be securely attached at the point of such transition. Where the lines extend under a building without re-emerging above grade prior to entering a building the tracer wire shall be securely attached at the point where the transition occurs.
- C. Please note that these particular requirements pertain to underground facilities on private property and will be regulated by the Building Official (Building Department). They are in addition to requirements required by the Authority Having Jurisdiction.
- D. Detectable requirements for underground facilities in rights of way will be regulated and monitored by the Authority Having Jurisdiction.

1.10 OPERATIONAL TAGS

- A. Furnish and install equipment identification tags for all items of mechanical equipment furnished and installed under Divisions 23, including each air conditioning unit, exhaust fan, pump, converter or heat exchanger, coil, chiller, cooling towers, special filter system, air washer, evaporative cooler and other equipment as listed in the mechanical equipment schedule.
- B. Mechanical equipment shall be labeled in an approved manner to permanently and uniquely identify each piece of equipment and the area served. Secure to units with screws at an appropriate location. Letters shall be engraved, 2" minimum.
- C. Labels for units located on roof or outdoors shall be a rust proof metal with engraved letters.

1.11 GUARANTEE-WARRANTY

- A. See Division 1 for warranties. As a minimum, the contractor shall warranty the entire mechanical system for a period of one year for parts and labor, unless specified in Division 1 to be a longer warranty period. The warranty period shall start from the date of beneficial occupancy.

PART 2 - PRODUCTS

2.1 QUALITY OF MATERIALS

- A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

2.2 ALTITUDE RATINGS

- A. Unless otherwise noted, all specified equipment capabilities are for an altitude of 2600 feet above sea level and adjustments to manufacturers ratings must be made accordingly.

2.3 ELECTRICAL SERVICES - MOTORS

- A. Provide and install all motors as manufactured by General Electric, Reliance Motor Co., or accepted equivalent. Each motor, unless otherwise specified of 3/4 HP and greater, shall be designed for operation with 3 phase, 60 Hz, 208 volt electrical service, as scheduled. Unless otherwise specified, motors of 1/2 HP and less shall be designed for operation with single phase, 60 Hz, 120 volt electrical service. Motors shall be 1750 RPM, squirrel cage, normal starting torque and normal starting current, in accordance with NEMA standards unless otherwise specified. All motors 5 HP and above shall be high efficiency motors with a minimum efficiency of 0.87 and a minimum power factor of 0.85. Each motor shall be of the horsepower as specified and suitable for use at an altitude of 1200 feet. All motors shall have grease lubricated sealed ball bearings. Motors larger than 1 hp shall have a standard grease fitting "zerk" and a separate grease relief tapping. Motors shall be factory lubricated. Motors shall be commercially dynamically balanced and tested at the factory before shipment and shall be selected for quiet operation.
- B. Motors for V-belt drives shall be provided with a cast iron or steel base, with slide rail and adjustable belt tension screw device. The Contractor shall line up motors and drives and place motors and equipment on foundations ready for operation.
- C. Provide totally enclosed, fan cooled (TEFC) motors outside the building or otherwise exposed to weather, or suitably protected per NEMA standards. Provide open drip proof motors generally inside the building, except where splash-proof or explosion proof construction is required.
- D. Provide single phase motors of permanent split capacitor type unless otherwise specified. Provide with integral thermal overload protection.

2.4 ELECTRICAL GROUNDING

- A. The mechanical piping system may be bonded to the electrical ground bus at the electrical service equipment, but shall not under any circumstances be used as the main grounding electrode for the electrical service.

2.5 V-BELT DRIVES

- A. V-belt drives shall be of fabric and rubber construction of accepted manufacturer. Multiple belts shall be matched and all belts shall be adjusted to drive the apparatus properly and to prevent slippage and undue wear in starting. Unless otherwise specified in the Mechanical Equipment Schedule, drive horsepower rating shall be 150 percent of the specified motor nameplate rating. Motor sheave shall be adjustable unless otherwise specified in the Equipment Schedule on the Drawings. All belts shall be "Standard" strength unless otherwise required. All V-belt drive equipment shall have a label showing type and size of belt required fastened to belt guard or other conspicuous location.

2.6 PAINTING

- A. All finish painting of mechanical equipment, piping, ductwork, and conduit will be under Section 09 91 00, Painting, unless equipment is hereinafter specified to be provided with factory applied finish coats.
- B. All equipment shall be provided with factory applied finish, unless otherwise specified.

2.7 TOUCH-UP

- A. If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Architect.
- B. One can of touch-up paint shall be provided for each different color factory finish which is to be the final finished surface of the product.

2.8 ADHESIVES, SEALANTS, AND PRIMERS

- A. All adhesives and sealants used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) shall comply with the requirements of the following reference standards:

1. Adhesives, Sealants, and Sealant Primers shall be under the maximum limits as set by the South Coast Air Quality Management District (SCAQMD) Rule #1168. VOC limits are listed in the table below and correspond to an effective date of July 1, 2005 and rule amendment date of January 7, 2005.

<u>ADHESIVES, SEALANTS SEALANTS PRIMERS</u>	<u>VOC Limit [g/L less water]</u>
PVC Welding	510
CPVC Welding	490
ABS Welding	325
Plastic Cement Welding	250
Adhesive Primer for Plastic	550
Contact Adhesive	80
Special Purpose Contact Adhesive	250
Multipurpose Construction Adhesives	70
Metal to Metal Adhesives	30
Plastic Foams	50
Wood	30
Fiberglass Adhesives	80
Sealants	420
Sealant Primers	750

2. Aerosol Adhesives shall be under the maximum limits as set by the Green Seal Standard for Commercial Adhesives GS-36 requirements in effect on October 19, 2000.

<u>AEROSOL ADHESIVES</u>	<u>VOC Weight [g/L minus water]</u>
General Purpose Mist Spray	65% VOC's by weight
General Purpose Web Spray	55% VOC's by weight
Special Purpose (All Types)	70% VOC's by weight

2.9 BELT AND FAN GUARDS

- A. The Contractor shall provide for each V-belt drive a galvanized iron belt guard which shall be constructed around an angle iron frame, securely bolted to the floor or apparatus. The guard shall completely enclose drives and pulleys and be constructed to comply with all safety requirements. Hinged access doors not less than 6" X 6" shall be provided for access to motors and fan shaft for test purposes. Furnish wire mesh screen cover reinforced with bars or rods for propeller fans, installed so as not to restrict the air flow. All zerk fittings and oil cups shall be accessible without removing belt guards. All belt guards shall be constructed in accordance with OSHA requirements.

2.10 WALL AND CEILING ACCESS DOORS

- A. Provide all access doors required for access to valves, traps, unions, coils, cleanouts, junction boxes, expansion joints, dampers, controls, or other items for which access is required for either operation or servicing. All costs incurred through failure to perform this function as the proper sequence of this work dictates shall be borne by the Contractor. The type of access door shall be as required by the room finish schedule. Acoustical tile access doors shall be equivalent to Krueger Style B, Style A for acoustical plaster or Style C-CE for sidewall drywall or plaster construction.
- B. Access doors shall not be less than 24" x 24" in size except that larger panels shall be furnished where required, and panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.

- C. Where access doors are installed in walls required to have a specific fire rating, the access door installed shall be fire rated access door with U.L. label, as manufactured by Milcor or accepted equivalent. Access door in 1-hour construction shall be Class C and access doors in 2-hour construction shall be Class B.

2.11 PIPING ISOLATION FROM THE SUPPORT

- A. All copper piping shall be isolated from steel supports with factory manufactured isolators. Taping as substitution for manufactured isolators will be not accepted.

PART 3 - EXECUTION

3.1 COOPERATION WITH OTHER TRADES

- A. The Contractor shall fully examine the drawings and specifications of other trades to become familiar with all conditions affecting the work and consult and cooperate with other Divisions for determining space requirements and clearances with respect to other equipment, hangers, piping, and conduit in the building. The Architect reserves the right to determine space priority in the event of interference between piping, conduit, and equipment of various trades. Construction operations shall proceed without harm to the Owner from interference, delay, or absence of coordination.
- B. If work is installed without coordinating with other trades, and such installation interferes with their installation or proper clearances around equipment is not maintained, then make changes to correct the conditions without extra cost.
- C. The Contractor shall be responsible for the size and accuracy of all openings.

3.2 INTERRUPTING SERVICES

- A. The Contractor shall coordinate the installation of all work within the building in order to minimize interference with the operation of existing mechanical, plumbing, and utility systems during construction. Connections to existing systems requiring the interruption of service within the building shall be carefully coordinated with the Owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted to the Architect in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written approval of the Architect.

3.3 INVESTIGATION OF CONDITIONS

- A. Examine the drawings and all available information concerning existing installation, structure, excavations, and local conditions bearing on labor, transportation, handling and storage of materials, etc. Visit the site to understand the nature and the scope of all work to be performed and verify existing conditions shown on the drawings. The submission of a bid will be taken as evidence that such an examination has been made and all conditions have been considered and verified.

3.4 DRAWINGS

- A. The mechanical drawings show the general arrangement of all piping, ductwork, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. The Architectural and Structural Drawings shall be considered as part of the work insofar as this information furnishes the Contractor with details relating to design and construction of the building. Architectural drawings shall take precedence over the mechanical drawings. Because of the small scale of the Mechanical Drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings, valves, and accessories as may be required to meet such conditions. Should conditions necessitate a rearrangement of piping, such departures and the reasons therefor shall be submitted by the Contractor to the Architect for approval in the form of detailed drawings.

3.5 FIELD MEASUREMENTS

- A. The Contractor shall verify the dimensions and conditions governing his work at the building. No extra compensation shall be claimed or allowed on account of differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, on which his work is dependent for efficiency, and shall report any work which must be corrected. Coordination of all mechanical work within the building will be the direct responsibility of the Contractor. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the mechanical work within the available space. No waiver of responsibility for defective work shall be claimed or allowed due to failure to report unfavorable conditions affecting his work. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor with all building trades. Installation of mechanical equipment within the ceiling cavity shall be in the following order of priority:

1. Plumbing soil, waste and roof drain lines.
2. Supply, return and exhaust ductwork.
3. Lighting, bus duct and electrical cable trays.
4. Fire sprinkler mains.
5. Domestic hot and cold water mains.
6. Vent piping (for waste system).
7. Fire sprinkler branch piping.
8. Domestic hot and cold water branch piping.

3.6 HANGERS, SUPPORTS, AND INSERTS

- A. Contractor shall provide support for all equipment, piping, and ductwork to the building structure. Contractor shall furnish all necessary structures, inserts, sleeves, and hanging devices for installation of mechanical and plumbing equipment, ductwork and piping, etc. Contractor shall completely coordinate installation of such devices with all trades and Sub-Contractors. Contractor must further verify with the Architect that the devices and supports are adequate as intended and do not overload the building's structural components in any way.
- B. Keep piping in proper alignment and prevent transmission of thrusts and vibrations. Hangers and supports shall be capable of screw adjustment after piping is installed. Hangers shall be finely adjusted in vertical and horizontal direction under operating conditions

3.7 PIPING AND DUCTWORK SEALANT THROUGH WALLS

- A. Sealant shall be capable of sealing pipe, conduit, and duct openings to restore fire and smoke rated walls and floors to their rated integrity. Sealant shall be UL classified. All penetrations in fire and smoke rated wall or floor assemblies shall be closed with 3M, or accepted equivalent, fire barrier penetration sealing systems and installed in accordance with the terms of their U.L. listing.

3.8 PROTECTION OF MATERIALS AND EQUIPMENT

- A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.
- B. The Contractor shall provide protection for all work where necessary and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be accepted by the Architect prior to such storage.
- C. Pipe openings shall be closed with caps or plugs to prevent lodgement of dirt or trash during the course of installation.
- D. Plumbing fixtures shall not be used by the construction forces. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Architect.

3.9 TRENCHING AND BACKFILLING

- A. All excavation, trenching and backfilling required for the mechanical installation shall be provided by this Contractor. Excavation and backfilling shall be done in strict accordance with Division 2, Site Work.

3.10 MANUFACTURER'S INSTRUCTIONS

- A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall report such conflicts to the Architect who shall make such compromises as he deems necessary and desirable.

3.11 CLEANING OF DUCTS

- A. Before the ceilings are installed and before ductwork located in tunnels or chases is covered, it will be required that the fans be operated at full capacity to blow out dirt and debris from ducts. If it is not practical to use the main supply blower for this test, the ducts may be blown out in sections by a portable fan.

3.12 EQUIPMENT FURNISHED BY OTHERS

- A. Certain items of equipment as listed on the drawings and/or specifications will be furnished by other Contractors or the Owner. This Contractor shall connect such equipment with utilities or ductwork to provide for proper operation in accordance with manufacturer's instructions.

3.13 LUBRICATION

- A. The Contractor shall provide all lubricants for the operation of all equipment until acceptance. The Contractor shall be held responsible for all damage to bearings while the equipment is being operated by him up to the date of acceptance of the equipment. The Contractor shall protect all bearings and shafts during installation.

3.14 TESTS

- A. The Contractor shall notify the Architect one week in advance of all tests. Contractor shall make all necessary preliminary tests to ensure a tight system. Any joint found leaking under test shall be broken, cleaned, remade, and a new test applied. Requirements for testing are specified under the sections covering the various systems. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.15 INSTALLATION CHECK

- A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated below shall visit the site of the work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Architect.
- B. Each equipment supplier's representative shall furnish to the Architect a written report certifying that the equipment (1) has been properly installed and lubricated; (2) is in accurate alignment; (3) is free from any undue stress imposed by connecting piping or anchor bolts; and, (4) has been operated under full load conditions and that it has operated satisfactorily.
- C. Equipment requiring installation check includes, but is not limited to the following:
 - 1. Roof Top Air Conditioning Units

3.16 OPERATIONAL TEST

- A. After completion of testing, adjusting and balancing work, see Section 23 05 93, the Contractor shall make an operating test covering all equipment furnished and installed under Divisions 23. This test shall cover a period of not less than 24 hours. The Contractor shall have all of his equipment operating and check all equipment for adjustments. The Contractor will instruct the Owner's operating personnel in the operation and maintenance of the systems in all specified modes.
- B. Operational test shall be conducted by the Contractor. Test shall be conducted in the presence of the Owner's Representative.

3.17 WARRANTY SERVICE

- A. Equipment items so noted will require factory authorized service personnel who shall provide all service, including all parts and all labor, as requested by the Owner during the full period of equipment warranty.

END OF SECTION

SECTION 23 05 21

VALVES AND PIPING SPECIALTIES

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.
- B. Lead Ban: Valves used in the installation of piping systems delivering water for human consumption shall be lead free. The term lead free is defined as valves which do not contain more than 8.0% lead.

1.2 RELATED SECTIONS

- A. See Section 23 01 00 for general mechanical requirements.
- B. See Section 23 01 00 for valve identification.
- C. See Section 23 20 00 for pipe fittings.

1.3 SCOPE

- A. Contractor shall furnish and install all valves and accessories necessary for satisfactory operation of the systems. All valves are to be of domestic manufacture only.
- B. Contractor shall submit complete submittal data, See Section 23 01 00, for all valves including manufacturer's specifications, class type, catalog data sheets, etc..

1.4 VALVE REQUIREMENTS

- A. All valves except lubricated plug valves and butterfly valves shall be manufactured by Milwaukee, Crane, NIBCO, Kennedy, Stockham, Walworth, Powell, Watts, Hammond, Conbraco, or accepted equivalent.
- B. Lubricated plug valves shall be manufactured by Resun, Nordtrom, Rockwell or Walworth.
- C. Valves installed in insulated piping systems shall be furnished with valve stem extensions.
- D. All valves of the same type shall be products of a single manufacturer. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.

PART 2 - PRODUCTS

2.1 BALL VALVES

- A. Ball valves shall be cast of ASTM B-62 or B-584 bronze, 600 lb. W.O.G. 150 lb. WSP, chrome plated ball, full port, blow-out proof, threaded gland follower, reinforced teflon seats, N.A. packing, full port type. NIBCO T-585-70 threaded, S585-70 soldered, or Apollo 77-100 threaded, 77-200 soldered, or Watts B-6080 threaded, B6081 soldered.

2.2 WATER PRESSURE REDUCING VALVES

- A. Water pressure reducing valve and strainer shall be installed on the water service pipe near its entrance to the building where supply main pressure exceeds 80 PSI to reduce it to 60 PSI or lower. The valve shall be constructed using lead free materials. Approved valves shall comply with ASSE. Valve shall be Watts Series LFN55B or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All valves shall be installed in locations which will allow easy operation and facilitate maintenance.
- B. Valves installed on insulated services shall be provided with extensions, as required, such that operator does not interfere with insulation or insulation jacketing.

3.2 TEST AND ADJUSTMENT

- A. Contractor shall field adjust all water pressure regulating valves, flow switches, water level controls, and specialties to provide required system operation.
- B. Contractor shall field test and verify the operation of all safety devices including water relief valves, and temperature and pressure relief valves.

3.3 RELIEF VALVE DISCHARGE

- A. Water pressure relief valve and water temperature and pressure relief valve discharges shall be piped full size to the outside of the building or discharged indirectly in a properly sized building floor drain or floor sink as approved by the Architect and allowed by the Building Mechanical and Plumbing Codes. When the operating discharge temperature is in the excess of 212 degrees F, the discharge shall be equipped with a splash shield or centrifugal separator.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING & BALANCING OF MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. All Division 22, 23, and 25 specification sections, drawings, and General Provisions of the contract, including General Conditions and Division 1 specifications, apply to work of this section, as do other documents referred to in this section.

1.2 REQUIREMENTS

- A. The testing, adjusting and balancing of the mechanical systems shall be performed by an independent testing and balance (TAB) agency accepted by the Engineer.
- B. The balancing shall be performed by agencies who have been regularly engaged in testing and balancing work for a minimum of five (5) consecutive years and who are certified by the Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB). The Contractor shall submit the qualifications and experience of all personnel who will be a part of the work group assigned to the project.
- C. The balancing agency shall not be associated with, or be the same Contractor furnishing the controls or instrumentation unless prior approved. Approved contractors shall be Commercial System Analysis, QC Analytical, Merick TAB, or prior approved equals.
- D. The testing and balancing agency shall not be associated with, or be the same company supplying equipment which will be a part of the mechanical systems to be tested or balanced.
- E. The Testing and Balancing Agency shall furnish all labor, materials, equipment and accessories as required to complete the system balancing.
- F. The Test and Balance Agency shall review the plans and specifications prior to installation of the system and submit a report to the Architect/Engineer of any deficiencies in the system which could preclude proper adjusting, balancing and testing of the system.
- G. The Test and Balance Agency shall inspect the system prior to adjusting, balancing and testing work to insure that all specified components which will affect proper execution of such work are installed and are operating properly including the temperature control system. A report shall be submitted to the Architect/Engineer indicating the results of the inspection.
- H. The Test and Balance Agency shall be in attendance during the testing of the piping and ductwork and shall submit a written report.
- J. Before final acceptance and after final adjustments have been completed the systems shall be balanced and an operating test performed. Balancing shall not begin until all systems are completed and in full working order. The operating test and training session shall not be performed until the Architect/Engineer has approved the test and balance report.
- K. Applicable requirements in ASHRAE 62.1 - 2004, Section 7.2.2 - "Air Balancing" shall be followed.
- L. Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.7.2.3 - "System Balancing" shall be followed.
- M. Instrumentation type, quantity and accuracy shall be as described in AABC's "National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems".

- N. Calibrate instruments at least every six months or more frequently if required by the manufacturer. Keep an updated record of instrument calibration that indicates dates of calibration.

1.3 SUBMITTALS

- A. Qualifications: The TAB Agency shall submit a company resume listing all personnel and project experience in air and hydronic system balancing and a copy of the agency's test and balance engineer (TBE) certificate.
- B. Procedures and Agenda: The TAB Agency shall submit the proposed TAB procedures and agenda to be used.
- C. Sample Forms: The TAB Agency shall submit sample forms, which shall include the minimum data required by the AABC's "National Standards for Testing and Balancing Heating, Ventilating and Air Conditioning Systems", or equal NEBB forms.

1.4 TAB PREPARATION AND COORDINATION

- A. The mechanical contractor shall have the system installation complete and equipment start-up complete prior to the TAB Agency's notice to proceed.
- B. The building control system shall be complete and operational. The building control system contractor shall install all necessary computers and computer programs, and make these operational.
- C. Coordinate the efforts of HVAC controls installers and other mechanics to operate the HVAC systems and equipment to support and assist TAB activities. Qualified installation or start-up personnel shall be readily available for the operation and adjustment of the systems.
- D. Perform testing and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed
- E. Testing and retesting of duct smoke detectors and fire/smoke dampers shall be accompanied by the electrician and/or the control system supplier. If the building has a fire alarm panel, a representative of the manufacturer must be present during the testing and retesting to by-pass the alarms.

1.5 WARRANTY

- A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes 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.
- B. The testing and balancing firm shall provide a written certificate of guarantee to the Engineer guaranteeing the performance of the balance work to the certification agencies procedures and these specifications. The guarantee shall warrant test repeatability for a period of 90 days from the date of balance. The balance agency shall retest any readings listed in the report as requested by the Engineer within this time period.

1.6 REPORT

- A. Upon completion of tests, all information shall be included in complete test and balance reports. The final report shall be included in the operating manuals prepared by the Contractor.
- B. Final TAB Report - The TAB agency shall submit the final TAB report for review by the engineer. All outlets, devices, HVAC equipment, etc., shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards. Submit seven (7) copies of the Final TAB Report. The engineer shall retain one (1) copy for their records.
- C. Life Safety Report - The General Contractor shall verify that all smoke control devices are installed and operating properly. After all devices have been proven to be operating properly, make arrangements with Kraemer Consulting Engineers, P.L.L.C (KCE) to test all devices in order to prepare a report on the operation of such devices. The report shall be sealed and signed by KCE, the Engineer of Record. The General Contractor shall compensate KCE for the test and report. Contact KCE for a proposal to perform this service. TAB Contractor shall notify the General Contractor of this requirement.

1.7 DEFICIENCIES

- A. Any deficiencies 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 person.
- B. The work necessary to correct items on the deficiency listing shall be performed and verified by the affected contractor before the TAB agency returns to retest. Unresolved deficiencies shall be noted in the final report.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. The Testing and Balance Agency shall provide not less than the following instruments and equipment for testing and balancing purposes.
 - 1. Pitot tubes and draft gauges.
 - 2. Capture boxes, calibrated.
 - 3. Velometer, calibrated.
 - 4. Thermometers, mercury and bi-metallic stem types.
 - 5. Ampere - voltmeter.
 - 6. Speed Indicator.
 - 7. Calibrated Water Flowmeter.
- B. All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with National Standards.

PART 3 - EXECUTION

3.1 SCOPE OF WORK

- A. Examine the Contract Documents and provide testing, adjusting and balancing of all HVAC equipment and systems that are part of the project.
- B. The items requiring testing, adjusting, and balancing include, but shall not be limited to, the following:
 - 1. Air Systems:
 - a. Supply Fans
 - b. Return Fans
 - c. Relief Fans
 - d. Exhaust Fans
 - e. Zone branch and main ducts
 - f. Diffusers, Registers and Grilles
 - g. Coils

3.2 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. Verify that balancing devices, such as test ports, 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 1 Section "Project Record Documents"
- D. 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.
- E. 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.
- F. Examine HVAC system and equipment installations to verify that indicated balancing devices such as test ports, flow-control devices, 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.
- G. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- H. 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.
- I. Examine strainers for clean screens and proper perforations.
- J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- K. Examine equipment for installation and for properly operating safety interlocks and controls.
- L. 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.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Automatic temperature-control systems are complete and operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Balance, smoke and fire dampers are open.
- B. Upon completion of the air conditioning system, the TAB Agency shall perform the below specified tests, compile the test data and submit seven (7) copies of the complete test data to the Architect.
- C. All information necessary to complete a proper TAB project and report shall be per AABC standards unless otherwise noted. The descriptions for work required, as listed in this section, are a guide to the minimum information needed.
- D. Cut insulation, ducts 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.
- E. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, manual valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- F. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 AIR SYSTEMS

- A. The TAB agency shall verify that all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set in the full open position. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards:
 - 1. For supply fans:
 - a. Fan speeds - Test and adjust fan RPM to achieve maximum or design CFM.
 - b. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
 - c. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total CFM.
 - d. Outside Air - Test and adjust the outside air on applicable equipment using a Pitot-tube traverse. If a traverse is not practical use the mixed-air temperature method if the inside and outside temperature difference is at least 20 degrees Fahrenheit or use the difference between Pitottube traverses of the supply and return air ducts.
 - e. Static Pressure - Test and record system static profile of each supply fan.
 - 2. For return fans:
 - Fan speeds - Test and adjust fan RPM to achieve maximum or design CFM.
 - a. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
 - b. Pitot-Tube Traverse - Perform a Pitot-tube traverse of the main return ducts to obtain total CFM.
 - c. Static Pressure - Test and record system static profile of each return fan.

3. For relief fans:

Fan speeds - Test and adjust fan RPM to achieve maximum or design CFM.

- a. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
- b. Static Pressure - Test and record system static profile of each relief fan.
- c. Pitot Tube Traverse - If possible, per system ductwork, perform a traverse to determine Relief Air CFM.

4. For exhaust fans:

Fan speeds - Test and adjust fan RPM to achieve maximum or design CFM.

- a. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
- b. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main exhaust ducts to obtain total CFM.
- c. Static Pressure - Test and record system static profile of each exhaust fan.

5. For zone, branch and main ducts:

Adjust ducts to within design CFM requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

6. For diffusers, registers and grilles:

- a. Tolerances - Test, adjust, and balance each diffuser, grille, and register to within 10'- of design requirements. Minimize drafts.
- b. Identification - Identify the type, location, and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

7. For coils:

- a. Air Temperature - Once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.
- b. Record refrigerant suction pressure and temperature for refrigerant coils.
- c. Record air flows and air pressure drop.

3.5 ADDITIONAL TESTING

- A. If initial testing and balancing procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting and adjusting during near-peak summer and winter conditions.
- B. The TAB agency shall return and perform additional testing during near-peak conditions at no additional cost.

3.6 OTHER REQUIRED TAB SERVICES

A. Preconstruction Plan Check and Review:

1. The TAB agency shall review the project documents and contractor submittals for their effect on the TAB process and overall performance of the HVAC system. It shall submit recommendations for enhancements or changes to the system within 30 days of document review.

B. TAB Report Verification:

1. At the time of final inspection, the TAB agency may be required to recheck, in the presence of the owner's representative, specific or random selections of data recorded in the certified report. Points and areas for recheck shall be selected by the owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

3.7 OTHER REQUIRED SERVICES PERFORMED BY OTHERS

A. Life Safety Report:

1. The General Contractor shall verify that all smoke control devices are installed and operating. After all smoke control devices have been found to be operating properly, contact the Kraemer Consulting Engineers, P.L.L.C (KCE) to test all devices and prepare a report on the operation of such devices. The General Contractor shall compensate KCE for the test and the report. Contact KCE for a proposal to perform this service. TAB Contractor shall notify the General Contractor of this requirement.
 - a. Testing of duct smoke detectors, the building smoke detection system, and fire/smoke dampers shall be accompanied by the electrician and/or the control system supplier. If the building has a fire alarm panel, a representative of the manufacturer must be present during the testing and retesting to by-pass the alarms.
 - b. The final test report shall be confirmed, sealed, and signed by Kraemer Consulting Engineers, P.L.L.C (KCE), the signatory engineers on this project. The testing may be performed by KCE or qualified agent of KCE, but not by the installing contractor. Reports signed by individuals, other than KCE, are unacceptable.
 - c. All reports shall contain the following:
 1. Project address including suite number.
 2. Stipulation that activation testing was performed using canned "smoke".
 3. Notation that a related fan shut-down when smoke was sensed at the smoke detector(when applicable).
 4. The Engineer's seal and signature, with the signature over the seal.
 - d. All reports shall contain a summary statement from the Professional Engineer that includes the following:
 1. Notation that the application and installation of all surveyed equipment complies with manufacturer's instructions.
 2. Pressure differential readings at each smoke detector.
 3. The flow velocity range for each installed smoke detector and confirmation that local duct velocity will never exceed these limits.
 4. Location and length of the smoke sensing probe(s) shall be confirmed as being appropriate (where applicable).
 5. A stipulation that each smoke activated element of the system was tested and that each passed.
 6. A detailed air balance report shall be attached when appropriate for confirmation of the designed flow velocities as stipulated in the smoke detector/smoke damper report.
 - e. The report shall be furnished to the General Contractor and the City Building Official (mechanical inspector). All discrepancies shall be brought to the immediate attention of the contractor for corrections, then, if uncorrected, to the city mechanical inspector.

- f. The final sealed and signed report shall be submitted to the Owner stating whether the work requiring special inspection was, to the best of the tester's knowledge, in conformance with the approved plans and specifications and the applicable workmanship provisions of this code.
- g. The Report shall be submitted in the Operation and Maintenance Manual.

END OF SECTION

SECTION 23 07 00

MECHANICAL SYSTEMS INSULATION

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.
- B. See Section 23 01 00 for general requirements.

1.2 SCOPE

- A. Cooling coil condensate drain pipe.
- B. Ducts, including air conditioning supply air and return air ducts and plenums.

1.3 TESTING

- A. All piping and ductwork shall be tested and accepted before any insulation is applied.

1.4 FITTINGS

- A. All fittings except as otherwise specified, shall be insulated with the same material and thickness as specified for the pipe.
- B. Unions, flanges and valves on hot water will not require insulation.

1.5 QUALITY ASSURANCE

- A. Qualifications
 - 1. Manufacturer - Company specializing in manufacturing products specified with a minimum 5 years documented experience.
 - 2. Installer - Company specializing in performing the work of this section with a minimum 5 years documented experience.

PART 2 - PRODUCTS

2.1 INSULATION

- A. Insulation shall be as manufactured by Owens-Corning Fiberglass, Gustin-Bacon, Johns-Manville, or Armstrong, Manson, or accepted equivalent, and shall be equivalent to that specified below.
- B. Insulation and all materials on the interior and exterior surfaces of ducts, pipes, and equipment shall have a composite fire and smoke hazard rating not exceeding: Flame spread - 25; fuel contribution - 50; smoke developed - 50, as determined in accordance with ASTM Standard E-84. Linings in ducts, plenums, and equipment shall meet the Erosion Test Method described in Underwriter's Laboratory Publication No. 181. Insulation shall have a "k" factor of 0.23 at 75 deg. F mean temperature unless otherwise indicated. All insulation materials used for valves and fittings shall have the same ratings as the insulation. Information must be submitted to Architect by means of manufacturer's literature showing that the materials conform to above specification without exception.

2.2 FITTINGS

- A. Fittings, where required to be insulated, shall be covered with fitting mastic reinforced with fiberglass fitting tape and finished to a smooth surface or prefabricated or molded insulation may be used on all fittings where applicable, providing materials meet specified fire and smoke hazard ratings.

2.3 PVC FITTING COVERS

- A. PVC fitting covers may be used for all valves and fittings requiring insulation provided the materials used meet the fire and smoke hazard ratings specified above, and only where the valves and fittings have been wrapped with fiberglass blanket insulation of the same thickness of insulation used on the pipe. Fiberglass blanket shall be held in place with soft copper wire and adhesive applied to the valve or fitting.

PART 3 - EXECUTION

3.1 SUPPLY AIR AND RETURN AIR DUCTS

- A. All supply air and round return air ducts shall be insulated except pre-insulated flexible ducts.
- B. Supply air and round return air ducts shall be wrapped with 2" thick ($R = 6.0$), Johns-Manville Microlite, FSK facing. The insulation shall be held in place with spot daubing of a quick tacking rubber base adhesive on approximately 6" centers. All end and longitudinal joints shall be butted firmly and the vapor barrier shall be overlapped not less than 2" and sealed continuously with Benjamin Foster 85-20. If staples are used, seal over staples with Childers CP-32, or accepted equivalent. Duct tape will not be permitted.

3.2 INSULATION AT VALVES

- A. The termination of all insulation on pipes at valve connections or unions, etc., shall be beveled and finished same as called for on all fittings.

3.3 ACOUSTICAL LINING

- A. Acoustical lining shall be Johns-Manville "Linacoustic RC" fiberglass duct liner with reinforced coating system, or accepted equivalent. All acoustic lining shall have a fire and smoke hazard rating not exceeding: Flame spread - 25; smoke developed - 50. The lining shall be applied using Benjamin Foster 85-20 adhesive and also secured on not more than 16" centers with Stick-Clips (on concrete) or welded pins (on metal) and held with washers not less than 1-1/4" diameter. The acoustic lining shall be installed to completely line the ducts. Acoustic lining shall be 1-1/2" thick ($R = 6.0$), unless otherwise specified.
- B. Ducts must be lined under the following conditions:
 - 1. Where specifically indicated on drawings.
 - 2. All transfer ducts, and return air boots.
 - 3. All supply and rectangular return air ductwork stubbed through roof.
 - 4. All exhaust ductwork.
 - 5. Where exposed to view.
 - 6. Where installed on roof, use 2" thickness ($R = 8$).
 - 7. All rectangular return air ductwork.
 - 8. First 10'-0" minimum of all supply ductwork.
- C. Duct sizes are "clear inside" dimensions. Adjust sheet metal sizes accordingly.

3.4 FACTORY INSULATED EQUIPMENT

- A. Domestic hot water heaters shall be factory insulated.

3.5 APPLICATION

- A. No pipe insulation shall be applied until piping has been pressure tested and accepted. No duct insulation shall be applied until the ducts have been inspected and accepted. All insulation shall be applied in strict accordance with the manufacturer's recommendations.

3.6 VICTAULIC COUPLINGS

- A. Where Victaulic type couplings or similar piping systems are used, all couplings shall be insulated in approved manner with insulation thickness equal to the piping system. Insulation of couplings shall be as specified herein for fittings.

3.7 PIPE HANGERS

- A. See Section 23 20 00 for requirements concerning protection of insulation at hangers.

3.8 COIL CONDENSATE DRAINS

- A. All condensate drain lines inside the building shall be insulated for the first 10'-0" with flexible closed cell foamed plastic pipe insulation, Armstrong Armaflex, Therma-Cel, Imcoa, or manufacturers named above. Fittings shall be field fabricated of nesting sizes, secured with adhesive. In return air plenums, use AP Armaflex with flame spread rating no greater than 25 and smoke development rating or no greater than 50.

- 1. Provide ½-inch thickness for coil condensate drains.

END OF SECTION

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SECTION 23 20 00

PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, Supplementary Conditions and General Requirements.

1.2 RELATED SECTIONS

- A. See Section 23 01 00 for general mechanical requirements.

1.3 SUBMITTAL DATA

- A. Contractor shall furnish complete submittal data for all piping materials, including manufacturer's specifications, certifications, class, type and schedule. Submittal data shall additionally be furnished for pipe hangers and supports, pipe sleeves including sealing and fire safing materials and installation.

1.4 QUALITY ASSURANCE

- A. All pipe and fittings shall be of domestic (U.S.) origin.

PART 2 - PRODUCTS

2.1 FLOOR, WALL AND CEILING PLATES

- A. Where exposed pipes pass through finished floors, finished walls, or finished ceilings, they shall be fitted with chromium plated spun brass flanges. Plates shall be large enough to completely close the hole around the pipe, and shall not be less than 1-1/2" or more than 2-1/2" larger than the diameter of the pipes. All plates shall be securely held in place.

2.2 UNIONS AND FLANGES

- A. Piping 2-1/2" and larger to have bolted flange unions with gaskets of material suitable for the specified service. Flanges shall conform to Federal Specifications WW-F-406a, Class 125. Ground joint unions with brass to iron seats, conforming to Federal Specification WW-V-531c shall be used in piping 2" and smaller. Unions or flanges shall be installed at all valves and equipment connections.

2.3 HANGERS AND ANCHORS

- A. All piping shall be rigidly supported from the building structure by means of vertically adjustable swivel ring clevis type hangers suspended on threaded steel rods. Where pipes run side by side, support on rod and angle iron, or unistrut, trapeze hangers. Cast iron soil waste and vent piping shall have hangers not more than one foot on each side of every change in direction and 2'-6" on each side of every change in direction for all other piping. Piping system shall be installed in an approved manner and shall not overload the building structural frame. Contractor shall provide additional hangers and steel members as may be required to distribute the piping system load over several structural members where required or directed. Ellen, Fee and Mason, Grinnell, Michigan, and Superior are acceptable manufacturers.

<u>Steel Piping</u>	-	<u>Maximum Spacing</u>
1/2"	-	6'-0"
3/4" through 1-1/4"	-	8'-0"
1-1/2" through 2-1/2"	-	10'-0"
3" through 12"	-	12'-0"

<u>Copper Piping</u>	-	<u>Maximum Spacing</u>
1/2"	-	6'-0"
3/4", 1"	-	8'-0"
1-1/4" through 2"	-	10'-0"
2-1/2" and above	-	12'-0"

<u>Cast Iron Piping</u>	-	<u>Maximum Spacing</u>
3"	-	1 ea. joint
4" and 5"	-	1 ea. joint
6"	-	1 ea. joint

The above spacing is the general case. Do not exceed the loading allowance on the structure. Reduce the hanger spacing in order to meet the loading allowance as required.

- B. Round rods supporting the pipe hangers shall be of the following dimensions:

<u>Steel Piping</u>	-	<u>Hanger Rod size</u>
1/2" through 2"	-	3/8"
2-1/2", 3"	-	1/2"
4", 5"	-	5/8"
6"	-	3/4"
8" through 12"	-	7/8"

<u>Copper Piping</u>	-	<u>Hanger Rod size</u>
1/2" through 2"	-	3/8"
2-1/2" through 5"	-	1/2"
6" and above	-	3/4"

<u>Cast Iron Piping</u>	-	<u>Hanger Rod size</u>
3"	-	1/2"
4" and 5"	-	5/8"
6"	-	3/4"

- C. Hangers for copper tubing shall be insulated from the tubing or hangers shall be of copper construction. Rods for trapeze hangers shall be a minimum of 3/4" and shall have the equivalent cross section listed above per pipe supported. The use of pipe hooks, chains, or perforated iron for pipe supports will not be permitted. Contractor shall provide a 8" long, 14 gauge galvanized steel protection saddle for all insulated pipes where pipe is resting on hangers, trapeze, unistrut, or other similar support structure. The Contractor shall provide inserts in the building construction at the time the concrete is poured, and the hangers shall be attached to these inserts. Where inserts cannot be used, expansion shields may be used provided the hanger is not attached rigidly to the bolt but is supported from an angle held in place by the expansion bolt. Anchors and guides shall be provided where required for proper control of expansion and contraction.
- D. Attachment of piping hangers to the building structure shall be provided in a manner accepted by the Architect.

2.4 CONDENSATE DRAIN PIPING

- A. Condensate drain piping shall be ASTM B-88, Type "M" hard drawn with wrought copper fittings and soldered joints, 50/50 solder.
- B. The Contractor shall extend condensate drain lines from all air conditioning equipment as shown on the drawings.
- C. The Plumbing Contractor shall coordinate and install a tail piece with a condensate drain connection as required by the mechanical drawings for condensate piping which ties into a lavatory tail piece.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Provide and erect, in a workmanlike manner, according to the best practices of the trade, all piping shown on drawings and required for the complete installation of these systems. The piping shown on the drawings shall be considered as diagrammatic for clearness in indicating the general run and connections, and may or may not in all parts be shown in its true position. The piping may have to be offset, lowered or raised as required or as directed at the site. This does not relieve the Contractor from responsibility for the proper erection of systems or piping in every respect suitable for the work intended as described in the specifications and accepted by the Architect. In the erection of all piping, it shall be properly supported and proper provisions shall be made for expansion, contraction and anchoring of piping. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked into place without springing and/or forcing, properly clearing all windows, doors, and other openings and equipment. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burrs and/or cutting slag removed by reaming or other cleaning methods. All changes in direction shall be made with fittings. All open ends of pipes and equipment shall be properly capped or plugged to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton waste or similar materials may not be used in plugging. All piping shall be arranged so as not to interfere with removal and maintenance of equipment or filters or devices; and so as not to block access to manholes, access openings, etc. Flanges or unions as applicable for the type of piping specified shall be provided in the piping at connections to all items of equipment including refrigeration machines. All valves and specialties shall be so placed to permit easy operation and access, and all valves shall be regulated, packed and adjusted at the completion of the work before final acceptance. All piping shall be erected to ensure proper draining. Water piping may be run level but shall be free from traps.

3.2 JOINTS

- A. Solder Joints: Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings shall be made with a noncorrosive paste flux and solid 95-5 wire solder, unless otherwise specified. Cored solder or any solder containing lead will not be permitted.
- B. Insulating Fittings: Insulating fitting shall be used to connect dissimilar metals (such as steel and copper) to prevent electrolytic action. Insulating fittings will not be required between bronze valves and steel pipe, or between copper coil headers and steel pipe.

3.3 PIPE SLEEVES

- A. Piping will not be permitted to pass through footings, beams or ribs except where written consent of the Architect. Pipe sleeves shall be installed and properly secured in place at all points where pipes pass through concrete or masonry construction. Pipe sleeves, except sleeves in footings and beams shall be 24 gauge galvanized steel, and shall be of sufficient diameter to provide approximately 1/4" clearance around the pipe, and in cases of insulated pipes, approximately 1/4" around the insulation. Pipe sleeves in footings and beams shall be of steel pipe. Sleeves in footings shall be not less than 1" or more than 2" larger in diameter than the pipe to be installed. Pipe sleeves in floors shall extend 2" above finished floor in toilets or rooms where domestic water is used. Openings between piping and sleeves shall be made caulking. In addition, openings between piping and sleeves in all masonry, concrete interior walls or gypboard fire walls and partitions shall be tightly sealed to prevent gases from passing through the pipe sleeves in the event of fire. Where pipes pass through exterior walls, the annular space between the wall and the pipe shall be sealed by sealing elements made of caulking.

3.4 EXPANSION AND CONTRACTION

- A. The Contractor shall make all necessary provisions for expansion and contraction of piping with offsets or loops and anchors as required to prevent undue strain.

3.5 PROTECTIVE COATINGS

- A. All underground steel pipe shall be wrapped with "Scotchwrap" No. 50 tape to give not less than two complete layers on the entire underground piping system, or piping shall have X-Tru-Coat factory applied plastic protective covering.

3.6 TESTING

- A. Before any insulation is installed or before piping is covered or enclosed, all piping systems shall be tested and proven tight at not less than the maximum service pressure which the piping systems will be required to handle, unless otherwise specified. All tests shall be witnessed and accepted by the Architect or his authorized representative.
- B. Tests shall not be used to establish pressure ratings.
- C. Protect all piping and equipment against overpressure, collapse from vacuum, and hydraulic shock during the filling, testing and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed twice the normal rating.
- D. Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60°F. Note that some applicable codes may require testing above a specified minimum temperature.
- E. Remove from the system all pumps, turbines, traps, expansion joints, instruments, control valves, safety valves, rupture discs, orifice plates, etc., which might be damaged by the test, or are designated by the Architect.

3.7 FLUSHING, DRAINING, AND CLEANING PIPE SYSTEMS

- A. The Contractor shall flush out all water systems with water before placing them in operation. Other systems shall be cleaned by blowing them out with compressed air or nitrogen. After systems are in operation and during the test period, all strainer screens shall be removed and thoroughly cleaned.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform to the applicable provisions of the General Conditions, the Special Conditions and the General Requirements.
- B. Refrigerant piping accessories associated with Medical Equipment and Kitchen Equipment furnished under other sections of this specification shall be furnished and installed by the Equipment Sub-Contractor.

1.2 RELATED SECTIONS

- A. See Section 23 01 00, General Mechanical Requirements.
- B. See Section 23 20 00, Pipe and Pipe Fittings.
- C. See Section 23 07 00, Mechanical Insulation.

1.3 SCOPE

- A. The Contractor shall furnish and install the complete refrigerant piping system as shown on the drawings, and as recommended by the equipment manufacturer.
- B. The work included in this contract consists of furnishing all labor, materials, equipment, tools and services, and includes all costs whatsoever which may be required to completely install and place in operation the systems described herein.
- C. Furnish and install all concrete, grout, and other required materials to fill all blockouts and/or sleeves left open for the Contractor's convenience, or for the installation of this work.

1.4 QUALITY ASSURANCE

- A. All pipe and fittings shall be of domestic (U.S.) origin.

PART 2 - PRODUCTS

2.1 AIR COOLED CONDENSER

- A. Furnish and install air cooled condensers located on building roof as shown on the drawings. Air cooled condenser shall be of type and capacity as specified in the Mechanical Equipment Schedule on the drawings. See Section 23 30 00 for detailed description.

2.2 PIPING

- A. Refrigerant piping materials and installation shall be in accordance with the best working and piping practices for Freon refrigerants. The Contractor shall install the refrigerant piping using ACR seamless, ASTM B-88 copper tubing, hard drawn, Type "L" in the buildings, above ground and Type "K" soft tubing below ground, cleaned, capped and nitrogen pressurized, with silver solder joint. All piping shall be installed in a straight manner, free from traps, and shall be provided with plugged or capped ends, as it is erected, to prevent dirt from entering. The piping system shall be provided with gauges as required for the operation of the system. The piping is shown schematically on the drawings, verify exact arrangement and pipe sizing for equipment manufacturer.
- B. During erection and making the silver soldered or sil-flossed joints in the piping system, a constant purge of inert gas shall be injected into the system to prevent formation of copper oxide on the inside of the piping system. Inert gas may be either nitrogen, argon, or other similar gas.
- C. A complete refrigeration piping diagram shall be submitted for approval before any installation of the piping system is begun. The submittal shall show complete material list of items to be field installed including joining material, pipe, fittings, inert gas to be used for purge, method of evacuation, pipe sizing, valves, driers, solenoid valves, thermostatic expansion valves, charging and evacuation connections, and refrigerant charge required. The submittal shall also show the major items of equipment: chillers, condensers, receivers, etc., and the factory connections to them.

2.3 VALVES

- A. Expansion valves shall be of the thermostatic type as manufactured by Alco, Sporlan, or accepted equivalent, and shall be gas charged with capillary tube, external superheat adjustment and external equalizing connection. The expansion valves at each apparatus shall be protected by a strainer in the refrigerant liquid line to that group. The strainer shall be as manufactured by the Henry Valve Company, or accepted equivalent, not less than line size and provided with shut-off valves before and after, and furnished with the packaged reciprocating unit.
- B. Solenoid valves shall be suitable for the system in which they are used and shall be designed specifically for use with Freon refrigerants. Solenoid valves shall be furnished with the packaged reciprocating unit.
- C. Refrigerant line valves shall be packless type or packed type with gas tight cap seal with wheel, globe, angle, or "T" needle type, with hard metal seats and shoulders on stems to permit packing stuffing boxes while open under pressure, or sealed diaphragm type.

2.4 DRYER

- A. In each liquid line, install a suitable silica gel filter and dryer. Dryer shall be furnished with the chiller.

2.5 HEAT PUMP CHILLER

- A. Heat Pump chillers shall be furnished as specified in Section 23 60 00.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Piping installation shall conform to the requirements of Section 23 01 00, General Mechanical Requirements and Section 23 20 00, Pipe and Pipe Fittings.
- B. Installing mechanical contractor shall coordinate refrigerant piping requirements (sizing, accessories, etc.) with manufacturer and assume responsibility and cost for required items.
- C. Unit manufacturer shall provide, in writing, a guarantee of design performance and warranty for all systems. The refrigerant piping lengths shall be confirmed and included in letter of guarantee.

3.2 TESTING OF REFRIGERANT PIPING SYSTEM

- A. After the installation of the refrigerant piping system has been completed, all pipes shall be tested and proven tight for a period of 24 hours at a pressure of 300 lbs. per square inch using dry nitrogen. The Testing and Balancing Agency shall certify in writing that all tests were satisfactorily completed before the piping was concealed and shall submit the certification to the Architect.

3.3 EVACUATION AND CHARGING

- A. Upon completion of the piping pressure test, the refrigerant circuit shall be evacuated to 500 microns absolute using a closed tube manometer and a Beach-Russ, or equivalent, high vacuum pump to ensure tightness of the piping and to remove air and moisture from the piping system. Upon completion of evacuation and acceptance of the system tightness, the vacuum shall be broken by the introduction of the refrigerant.

3.4 REFRIGERANT AND LUBRICATING OIL

- A. Contractor shall furnish and install all of the refrigerant required to develop the system to its full rating, and in addition to the initial charge, shall be required to provide all refrigerant required for the proper operation of the refrigeration apparatus during the first season's operation. Contractor shall guarantee that the loss of refrigerant for a season's operation shall not exceed 10% of the full charge of the system and he shall furnish any refrigerant required above this amount. This guarantee shall remain in effect until such time as the Contractor shall demonstrate this performance for one full year's operation. The Contractor shall be required to provide the initial charge of lubricating oil for all refrigeration apparatus and related equipment, and shall furnish a chart listing the type of oil and a schedule for maintenance that should be used with the various equipment.

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SECTION 23 30 00

AIR-TEMPERING SYSTEM

PART 1 - GENERAL

1.1 REQUIREMENTS

- A. Conform with applicable provisions of the General Conditions, the Special Conditions and General Requirements.
- B. See Section 23 01 00 and 23 20 00 for general mechanical requirements and related work.

1.2 WORK SPECIFIED ELSEWHERE

- A. Insulation and Acoustical Treatment are specified under Section 23 07 00.
- B. Painting of equipment is covered under "Painting" in these specifications.
- C. Electrical Work as noted in Section 23 01 00, "General Mechanical Requirements".
- D. Duct Chases, Wall Openings and Equipment Foundations by General Contractor.

1.3 SCOPE

- A. Furnish and install air conditioning units, filters, sheet metal work, accessories and incidentals.

1.4 SOUND LEVELS

- A. Sound levels attributable to mechanical equipment such as terminal units, fan-coil units, centrifugal fans, etc. are designed to result in sound levels of NC 40 for retail spaces measured within the rooms. Mechanical equipment that has been substituted for the specified equipment shall perform within these sound limitations, or will be replaced or adjusted as required. Sound levels attributable to duct vibration that result in noticeable noise or vibration to duct hangers, lighting fixtures, ceiling tees or diffusers shall be resupported or adjusted until the disturbing noise is brought within acceptable limits.

1.5 DIMENSIONS

- A. The Contractor shall check all drawings furnished upon their receipt and shall promptly notify the Architect of any discrepancies. The Contractor shall compare all drawings and verify all dimensions both on the drawings and in the field before laying-out, cutting, and fabricating the work. Sheet metal work that is cut and fabricated from the Contract Drawings without dimensional verification will be at the risk of the Contractor.

PART 2 - PRODUCTS

2.1 EQUIPMENT SCHEDULES

- A. The capacities of all major items of equipment are specified in the Equipment Schedules on the drawings and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory operating system. Detailed descriptions of all major items of equipment are included in the related sections of specifications.

2.2 DUCTWORK

- A. Materials: Construct all ducts, casings, plenums, etc. from new hot-dipped galvanized steel sheets, ASTM A-120. Sheets shall be free of blisters, slivers, pits, and imperfectly galvanized spots. Reinforcing angles and bars, and duct support materials shall be galvanized steel. Construct and erect ductwork in accordance with the latest issues of SMACNA Standards and ASHRAE Guide. Comply in the Fabrication of joints, seams, bracings, reinforcement, hangers, fittings, housings, casings and special applications.
- B. All low velocity air conditioning supply air and return air ductwork to be 2-inch duct construction. Duct classified shall be in accordance with SMACNA Table 1-1.
- C. All low velocity exhaust ductwork except special ductwork specified herein shall be fabricated to 2-inch duct construction.
- D. Round ductwork shall be spiral seam with factory fabricated fittings.
- E. All exhaust ductwork shall be fabricated to 1-inch duct construction.
- F. Sealing shall be as required in the SMACNA Duct Construction Standards for construction pressure classes. Sealant shall not exceed a flame spread of 25 or a smoke development of 50, and shall be UL certified for flame spread and smoke development.
- G. Low velocity supply duct that is not acoustic lined, and all exhaust ductwork and return air shall have both longitudinal and traverse joints sealed with "Hardcast", or with high velocity sealer. Duct leakage as measured by summing CFM at individual registers shall be limited to 1% of the flow rate (CFM) measured at the fan. Exhaust and return air registers leaking at the ceiling joint, where air is being drawn from the ceiling cavity instead of being exhausted from the room, shall be sealed with high velocity cement.
- H. At the Contractor's option, rectangular ductwork may be substituted with round galvanized spiral seam duct. Spiral ductwork shall be gauged for 2" positive pressure class as specified in table 3-2A of the latest edition of SMACNA Duct Construction Standards. Seal all joints as specified above.

2.3 FLEXIBLE DUCTS

- A. Thermaflex Type M-KE for low pressure. Factory fabricated assembly, spiral construction with CPE liner bonded to a coated spring steel wire helix, fiberglass blanket insulation, and outer vapor barrier of fiberglass reinforced film laminate. Flexible ducts shall maintain dimensional integrity and shall be designed for the duct pressures encountered. Pressure rating shall be for 1-1/2 times the duct pressure at the connection. Flexible ductwork insulation shall have an "R" value of 6.0 minimum. Flexible ductwork shall meet U.L. 181 as a Class I air duct and not exceed a flame spread rating of 25 or a smoke development rating of 50. Flexible ducts shall not exceed 8 ft. in length.
- B. Install flexible ducts with a minimum of bends, and extended straight where possible. Minimum bend radius shall be 1-1/2 times the diameter of the duct measured from the centerline. For connections at diffusers or other low pressure applications shall be sealed and connected with stainless steel worm drive clamps.

- C. Round connections to rectangular ducts shall be made with either spin-in fittings or ½" flanged bottom taps as described under Air Control Dampers.
- D. Flexible ducts for connections between medium or high velocity ductwork and high pressure terminal units shall be a high pressure type capable of holding 6" W.C. of static pressure with dimensional stability and without developing leaks, and shall be equivalent to Thermaflex Type M-KC. Installation of flexible duct shall ensure that the inside radius of bends shall not be less than the duct diameter.

2.4 FIRE DAMPERS

- A. At the locations shown on the drawings, provide fire dampers. Provide access doors at all fire damper locations of sufficient size to allow easy inspection and resetting of fire damper linkages. Fire damper links shall be of the test strength recommended to prevent nuisance closing. All fire dampers shall conform to the requirements of NFPA Pamphlet 90A, and shall bear the Underwriter's Label. All fire dampers shall be furnished with sleeves. Fire dampers shall be installed inside the fire walls and supported as required by UBC and NFPA 90A.
- B. High Velocity Round or Oval Fire Dampers: High velocity fire dampers shall be of the folding blade type with the hinged damper blades completely out of the air stream so as to cause a minimum of static pressure drop. Fusible links shall be accessible from either side of the damper. Each damper shall be furnished complete with a galvanized welded steel sleeve (round or oval) and closure compartment to house the folded blades of gauges allowed by UL 555.
- C. Rectangular Fire Dampers: Fire dampers for rectangular ductwork shall be of the folding blade type with the hinged blades completely out of the air stream or of the single hinged blade type. Fusible links shall be accessible from either side of the damper. Each damper shall be furnished with a U.L. approved galvanized welded steel sleeve and closure compartment to house the folded blades as allowed by UL 555.

2.5 AIR CONTROL DAMPERS

- A. Manual Volume Dampers: Dampers shall be opposed or parallel blade type. Damper frames and blades shall be galvanized steel and a minimum of 16 gauge. Blade width shall not exceed 8 inches. Dampers and seals shall be suitable for temperature ranges of -50 to 250 degrees F. Damper linkage hardware shall be constructed of aluminum or corrosion resistant zinc and nickel plate steel. Round dampers shall have single blade with reinforced galvanized frame. Damper operators shall have manual locking quadrants. Where ducts are insulated, the hand quadrant shall be extended 2" away from the frame.
- B. Round Take-Offs From Rectangular Ducts: Diffuser and grille take-offs from rectangular ducts to round ducts shall be made with either a spin-in fitting or a ½" flanged bottom tap. Round take-offs shall be built from 26 gauge galvanized steel with a 24 gauge round damper blade and locking quadrant with 2" stand off to allow for insulation thickness. Damper blades shall be secured in set position with wing nuts. Round take-offs 13" diameter and larger shall be supplied with a solid rod and nylon bushings. Reference figure 7-4 of the 2005 edition of the SMACNA HVAC Duct Construction Standards.

2.6 ACCESS DOORS

- A. Wall, ceiling and duct access doors at fire dampers shall be Controlair 16-ga. access door with continuous hinge, gasket and thumb screw locks. Baked aluminum enamel finish on access door on finished surfaces. Size of fire damper access doors in low velocity ductwork shall be 2" less than the width of the duct by 12", up to a maximum size of 12" x 24". Access doors on insulated ductwork shall be installed on an extended metal collar flush with the insulation.
- B. Units shall have gaskets and close airtight. Metal doors in ducts lined with acoustical insulation shall be lined with the same thickness of acoustical insulation as the duct.

2.7 ACOUSTICAL LINING

- A. The acoustical lining shall be as specified in Section 23 07 11, Mechanical Systems Insulation. The acoustic sheets shall be installed to completely line the plenum walls and roof. After acoustic sheets have been installed, all joints shall be pointed up to a smooth surface with asphalt emulsion.

2.8 FILTERS

- A. Filters shall be as listed in the schedules on the drawings. Three (3) set of filters are required. Provide two (2) sets of specified filters for each piece of equipment. Install one (1) set of specified filters just prior to final testing and balancing, and install one (1) set of specified filters upon owner occupancy, or as directed by the owner. During construction furnish and install one (1) set of temporary filters to protect the equipment. Temporary filters may be throwaway filters in lieu of the specified filters.

2.9 TURNING VANES

- A. Turning vanes shall be installed in all square elbows in low velocity supply and exhaust ductwork. Turning vanes shall be high efficiency profile type.
- B. Furnish airfoil shaped acoustical turning vanes designed to reduce the dynamic air losses as well as the noise level. Turning vanes shall be non-corrosive and shall have fiberglass fill with open protective metal facing. Furnish galvanized steel mounting rails with prepunched locating holes on 3-1/2" centers designed to receive the turning vanes the full width or height of the duct. All square elbows shown on the supply ducts on the drawings shall incorporate acoustical filled turning vanes.

2.10 COILS

- A. Heating and cooling coils shall be ARI certified design and manufacture. In no case shall specified air or water pressure drops be exceeded more than 10 percent. Piping connections shall be as shown on the drawings. Coils shall be as specified in the equipment schedule on the drawings. In no case shall rows or fin spacing be less than the minimum surface scheduled.

2.11 GRILLES, DIFFUSERS, AND REGISTERS

- A. Grilles, Diffusers, and registers shall be fabricated of steel or aluminum. Steel grilles, diffusers, and registers shall receive a zinc phosphate prime coat and a baked enamel finish. Aluminum grilles, diffusers, and registers shall also be finished in a baked enamel finish. The type of grille, diffuser, and register is shown by symbol number on the drawings. All symbol numbers shall be cross checked against the Architectural Room Finish Schedule which shall govern in the event of a conflict; discrepancies shall be clearly noted on the submittals. Furnish additional t-bars as required to support and finish around ceiling mounted diffusers and grilles. Provide sponge rubber gasket around frame on all surface mounted supply diffusers, registers, and grilles. Equipment manufactured by Metalaire, J&J, Carnes, Krueger, Titus and E.H. Price or equivalent. Ductwork runouts connecting diffusers with round necks shall be the same size as the diffuser neck, unless otherwise noted. All grilles, diffusers, and registers shall be ADC (Air Diffusion Council) certified and rated in accordance with the ADC Equipment Test Code.

2.12 SMOKE DETECTORS

- A. The air duct smoke detector units shall be Pyrotronics Combination Photo-Electric/Ionization or equivalent. They shall be listed by Underwriter's Laboratories, Inc. The units shall be designed for detection of combustion gases, fire and smoke in air conditioning and ventilation system ducts, in compliance with the National Fire Protection Association, Recommended Practices Pamphlet No. 90A. It shall consist of a Pyrotronics ionization type detector with self-contained control unit. The assembly shall consist of a casting to accommodate sampling tubes which extend across the duct of the ventilation system. While the fans are operating, a continuous cross-sectional sampling of air from the duct will flow through the ionization detector, after which the sampled air shall be returned to the duct. System shall be 120 VAC and be compatible with the building fire alarm system as specified in Division 26 of this specification.

- B. The unit shall provide the following functions:
1. Furnish necessary DC power for operation of the detector.
 2. Supervise the detector circuit and all relay coils.
 3. Provide power to the neon alarm indicators.
 4. Provide one set of normally open and one set of single pole, double throw alarm operated relay contacts (5A, 120V, AC).
 5. Provide one set of single pole, double throw operated relay contacts (5A, 120V, AC).
- C. The unit shall be bolted directly to the duct or plenum wall. A template shall be provided for making necessary cutouts and holes. Complete instructions shall be provided with units.
- D. Unit shall be capable of stable operation from 0 deg. to 150 deg. F.
- E. Sampling tubes shall be EMT tubing, 1/2-inch diameter, length and supports as required to extend across plenum or duct. Quantity and location of sampling tubes shall be as required for representative sampling.
- F. Quantity and location of smoke detectors shall be as recommended by manufacturer to comply with NFPA 90A, but in no case less than indicated on the drawings.
- G. Smoke detectors located in HVAC systems and shown on the Pneumatic Control Diagrams and Mechanical Floor Plans shall be furnished, installed, tested and adjusted under this section of the specifications. 115 volt wiring shall be provided under Division 26 of this specification. Operation of smoke detectors shall be as indicated on the temperature control diagram.

2.13 RELIEF HOODS

- A. Relief Hood Description: Heavy gauge aluminum construction with hood constructed from formed, arched panels with interlocking seams, birdscreen, backdraft damper and roof mounting curb. Unit shall be capable of relieving the specified cfm at a maximum static pressure drop as scheduled on the plans. Greenheck "FABRAHOOD", Acme, Carnes, Cook, Western Vents & Curbs, or equal.

2.14 PACKAGED ROOF-TOP AIR CONDITIONING UNITS

- A. Single packaged, self-contained, factory assembled, pre-wired, UL listed, ARI certified unit consisting of cabinet and frame, indoor blower, evaporator coil, gas furnace, condenser fan, condenser coil, compressor(s), controls and filters.
- B. Units shall include a minimum five (5) year parts warranty coverage for compressors and one (1) year labor.
- C. Cabinet: Minimum 20 gauge gasketed and insulated cabinet panels with baked enamel finish, easily removed access doors or panels with quick fasteners. Insulation shall include acoustic duct liner with smooth, black neoprene air-side surface for lining cabinet interior. Unit shall have a factory installed, sloped condensate drain pan made of non-corrosive material extending under the complete evaporator coil.
- D. Evaporator Fan: V Belt-driven, with permanently lubricated bearings, double width, double inlet, forward curved centrifugal fan, statically and dynamically balanced, resiliently mounted.
- E. Evaporator and Condenser Coils: Seamless copper tubes mechanically bonded to aluminum fins. Coils shall be leak tested at the factory up to 200 psig and pressure tested to 450 psig. Each refrigerant circuit shall include expansion devices, service pressure ports and refrigerant line filter/driers. Provide condenser coil hail guard.
- F. Condenser Fan: Direct driven, with permanently lubricated bearings, thermal overload protection, weather proofed, vertical discharge, propeller type with fan guard, statically and dynamically balanced, resiliently mounted.

- G. Compressors: Hermetically sealed, resiliently mounted with positive lubrication, internal motor protection, and crankcase heater.
- H. Electric controls to be factory wired and unit mounted and shall include contactors, high and low pressure cutouts, low ambient control to operate in cooling down to 30 F, safety devices, 24 volt transformer, non-cycling reset relay, and indoor fan time delay relay.
- J. Gas-fired Furnace: Natural gas fired, self-contained, complete with burner and controls, AGA certified, aluminized steel heat exchanger, electronic ignition, minimum AFUE efficiency of 80 percent.
- K. Air Filters: Easily removable, 2" thick pleated type with Merv8 efficiency, Farr 30/30 or equal.
- L. Outside Air Intake: Automatic 3-position outside air intake damper with rain-hood and screen, capable of admitting up to 35% outside air.
- M. Provide factory fabricated unit support curb with base flange and nailer strips. Curb design shall allow ductwork to be directly connected to the curb. Provide pitched roof curbs on all pitched roofs. Contractor shall verify roof pitch prior to ordering curbs. Units shall be set level.
- N. Thermostat (Base Bid): Seven-day electronic programmable room thermostat with a minimum four offset periods per day. Automatic and manual changeover with a system (off-heat-cool-auto) switch, a fan (on-auto) selector switch and face cover. Unit completely factory wired for terminal connections of thermostat and power wiring. Wiring of thermostat is included in this section.
- O. Temperature Control (Alternate Bid): Provide as part of the building automation system.
- P. Manufacturer: Trane, Carrier, and Lennox.

2.15 DUCTLESS SPLIT SYSTEM AIR CONDITIONING UNITS

- A. The ductless split system shall utilize Variable Speed Inverter Compressor technology. The system shall consist of a horizontal discharge, single phase outdoor unit, a matched capacity indoor section that shall be equipped with a wired wall mounted controller. The unit capacities shall be as listed on the mechanical schedules.
- B. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.
- C. All wiring shall be in accordance with the National Electrical Code (N.E.C.) and local codes as required.
- D. The units shall be rated in accordance with Air-conditioning, Heating, and Refrigeration Institute's (AHRI) Standard 240 and bear the ARI Certification label.
- E. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- F. A dry air holding charge shall be provided in the indoor section.
- G. The outdoor unit shall be pre-charged with R-410a refrigerant for 70 feet (20 meters) of refrigerant tubing for the 1-2 ton units or 100 feet (30 meters) of refrigerant tubing for the 2.5 ton unit.
- H. System efficiency shall meet or exceed the SEER values as shown on the mechanical equipment schedule.
- I. Unit shall be stored and handled according to the manufacturer's recommendations.

- J. The controller shall be shipped inside the carton with the indoor unit and shall be able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.
- K. The units shall have a manufacturer's parts and defects warranty for a period five (5) year from date of installation. The compressor shall have a warranty of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.
- L. Outdoor Condensing Unit

1. Description

- a. The outdoor condensing unit shall be compatible with the indoor unit. The connected indoor unit shall be of the same capacity as the outdoor unit.
- b. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.
- c. The outdoor unit shall be capable of operating at 0°F (-18°C) ambient temperature without additional low ambient controls (optional wind baffle shall be required).
- d. The outdoor unit shall be able to operate with a maximum height difference of 100 feet (30 meters) between indoor and outdoor units.
- e. System shall operate at up to a maximum refrigerant tubing length of 100 feet (30 meters) between indoor and outdoor units without the need for line size changes, traps or additional oil.
- f. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.
- g. Outdoor unit sound level shall not exceed 50 Db(A)

2. Cabinet

- a. The cabinet casing shall be constructed from galvanized steel plate, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.
- b. Mounting feet shall be provided and shall be welded to the base of the cabinet and be of sufficient size to afford reliable equipment mount and stability.
- c. Easy access shall be afforded to all serviceable parts by means of removable panel sections.
- d. The fan grill shall be of ABS plastic.

3. Fan

- a. Models shall be furnished with a single AC fan motor.
- b. The fan blade(s) shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated.
- c. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent external contact with moving parts.

4. Coil

- a. The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up and allow maximum airflow. The coil shall be protected with an integral metal guard.
- b. Refrigerant flow from the condenser shall be controlled by means of an electronic linear expansion valve (LEV) metering device. The LEV shall be controlled by a microprocessor controlled step motor.

5. Compressor

- a. The compressor shall be a DC rotary compressor with Variable Speed Inverter Drive Technology.
- b. The compressor shall be driven by inverter circuit to control compressor speed.
- c. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
- d. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

6. Electrical

- a. The electrical power of the unit shall be 208volts or 230 volts, single phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts.
- b. Power for the indoor unit shall be supplied from the outdoor unit according to the manufacturer's wiring diagram.
- c. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC.

M. Indoor Evaporator Unit

1. Description

- a. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit, in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.

2. Unit Cabinet

- a. The cabinet shall be formed from high strength molded plastic with smooth finish, flat front panel design with access for filter. The unit shall be wall mounted by means of a factory supplied, pre-drilled, mounting plate.

3. Fan

- a. The indoor unit fan shall be high performance, double inlet, forward curve, direct drive fan with a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of three (3) speeds: Low, Mid, and Hi and Auto. The fan shall have a selectable Auto fan setting that will adjust the fan speed based on the difference between controller set-point and space temperature. Indoor unit sound level shall not exceed 45 dB(A) at high speed.

4. Filter

- a. Return air shall be filtered by means of an easily removable washable filter.

5. Coil
 - a. The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. A condensate mini-pump shall be provided integral to the unit.
6. Electrical
 - a. The electrical power of the unit shall be 208 volts or 230 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The power to the indoor unit shall be supplied from the outdoor unit according to the manufacturer's wiring diagram.
7. System Control
 - a. The control system shall consist of a minimum of two (2) microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. Field wiring shall run directly from the indoor unit to the wall mounted controller with no splices. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit. The control voltage from the wired controller to the indoor unit shall be 12/24 volts, DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time and diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.
8. Wall-mounted Controller
 - a. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large liquid crystal display (LCD). There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Heat/Cool/Auto mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, and a Fan Speed selector button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C). The controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat. Normal operation of the wired controller shall provide individual system control in which one wired controller and one indoor unit are installed in the same room. The maximum control cable distance shall be 1,500 feet (500 meters).
9. Manufacturers
 - a. Approved manufacturers shall include: LG, Emipair, Lennox, Carrier, Trane, Mitsubishi, or owner=approved equal.

2.16 EXHAUST FANS

- A. All fans shall be U.L. listed and AMCA certified.
- B. Submit fans clearly outside of unstable air range with adjustment available to increase or decrease rpm.
- C. Rooftop Exhauster: V-belt or direct driven, as indicated, centrifugal blower type. Curb base mounted, backward inclined non-overloading, aluminum centrifugal wheel, spun aluminum inlet shroud and cover, bird screen, and capable of exhausting the capacities scheduled on drawings. Greenheck, Penn, Cook, Carnes and Acme.
- D. Ceiling Exhauster: The fan housing shall be constructed of phosphatized steel with a baked enamel finish, with ½" thick acoustical lining. The discharge outlet shall be adaptable to horizontal or vertical position. The unit shall be complete with electrical terminal box, forward curved centrifugal blower with vibration isolators, integral grille, and backdraft damper. Install with pitched roof jack, flat roof cap or wall cap as indicated, or suitable for the application. Greenheck, Penn, Carnes, Cook, and Broan Mfg.
- E. Propeller Fans: Belt driven, axial type sidewall propeller fans, statically and dynamically balanced and constructed with fabricated steel, fabricated aluminum, or cast aluminum blades. Polished steel shafts shall be mounted in permanently lubricated ball bearing pillow blocks. Drive frame panel and collar assemblies shall be painted steel with bolted or welded construction. Include inlet and outlet guards conforming to OSHA requirements and wall mounting collar. Model numbers are Greenheck; approved equals shall include Penn, Peerless, Acme Mfg. or Cook.

2.17 HIGH VOLUME LOW SPEED (HVLS) FANS

- A. The fan shall be listed to applicable UL Standards and requirement by UL.
- B. The fan shall be equipped with aerospace aluminum, with fan diameters ranging from 8 to 24 feet. The airfoils shall be connected to individual aluminum 6005 T6 struts. Standard anodized finish with optional powder coated colors. Quantity of airfoils by manufacturer.
- C. The fan shall be equipped with a Radical Flux brushless DC motor designed for low speed high torque applications. The motor shall be driven sensor-less to eliminate the possibility of sensor or encoder failure. Variable frequency drive (off board) capable of 208 VAC single phase 60 Hz, 208 VAC three phase 60 Hz or 480 VAC three phase 60 Hz.
- D. Touch screen controller for individual (one to one) fan controller, four fan network controller, 30 fan network controller or BACnet system intergration.
- E. The fan mounting system shall be equipped with hardware, no less than SAE grade 5 for safe installation. The fan shall be quipped with a universal mount with optional rapid mount. Additional mounting options for I-beam, Purlin, and Glulam applications. Provide all guy wires, clamps, and drop lengths as specified.
- F. The fan shall be wired into the fire alarm/suppression system so that fan will automatically shut off within a maximum of 90 seconds after sprinklers are activated. To facilitate this structure ahut-down, the low voltage wire and relay needed to accomplish this must be supplied by the Fire Alarm installer.
- G. Warranty: 15 year warrant on airfoils and mounting. 10 year electrical warranty on motor, variable frequency drive and controller/remote.
- H. Manufacturer: MacroAir, Hunter, Epic, or BAF.

2.18 ELECTRIC WALL HEATER

- A. Heaters shall be UL Listed with capacities, voltages and control options as specified in schedule. Units shall be commercial quality with 18 gauge steel front cover. Cabinet to be finished with epoxy/polyester powder coated neutral beige finish.
- B. Provide durable tubular heating elements with fins.
- C. Provide 160 CFM blower with closed, factory lubricated motor. Fan delay shall be used to purge heater of residual heat.
- D. Terminals accept power source for connection to units with integral thermostat. Suitable for copper wire, sized at 125% of rated load per NEC.
- E. Built-in thermostat included with control knob or tamper proof. Optional 24 V relay with transformer is available for remote thermostat.
- F. Acceptable manufacturers include: Reznor, Brasch, Markel and Qmark.

2.19 ELECTRIC CABINET UNIT HEATER

- A. Heaters shall be UL Listed for cabinet and duct-connected application with capacities, voltages, mounting arrangements and control options as specified in schedule. Units shall be CH Romalox or approved equal, commercial quality with heavy duty 16 gauge cabinet, minimum radius edges and stiffeners on grilles and panels for extra strength. Cabinet to be phosphatized and finished with baked-on neutral beige combination primer/finish.
- B. Provide iron-free heating elements for maximum life with machine-crimped terminals, mounted to insure noiseless operation. Provide full length diffusion plate to protect against intrusion of foreign objects and effectively distribute discharge air across cabinet length.
- C. Fan housing with single or double shaft motor and blower shall be mounted as a removable assembly. Fan wheel and streamlined die-formed inlets shall be engineered for minimum noise level.
- D. Terminals accept power source for connection to 208V, units with integral thermostat. Suitable for copper wire, sized at 125% of rated load per NEC.
- E. Built-in controls on floor and wall-mounted units shall include three-position selector switch mounted behind a tamper proof access door for selection of heat-off-vent control functions. Built-in thermostat with adjustable setpoint shall be provided where scheduled. All units to have linear thermal cutout extended across the length of the unit to protect against overheating or partial air blockage with primary and independent secondary thermal safety protection. Disconnecting break contractors to be provided on all units. Supply branch circuit fusing for units over 48A.

2.20 MAKE-UP AIR UNIT

- A. Description: Make-Up is completely packaged on a single common curb. Unit shall be U.L. Listed and meet all NFPA 96 requirements. The make-up air fan shall furnish tempered air. The fan shall be belt driven with forward curved centrifugal blower. Blower assembly shall be mounted on vibration isolators. Blower and motor shall have permanently lubricated sealed ball bearings. The fan shaft shall be ground and polished steel, pulleys shall be fully machined, cast iron type, keyed and securely attached to the fan shaft. Drives shall be sized for a minimum of 150% of driven horsepower. Heavy gauge galvanized steel housing with removable panels. Unit shall be certified by AMCA for air performance with filters in place. Furnish with duct adapter, duct extension, 2" washable filters, intake damper control, roof mounted curb, disconnect switches, and control center. Greenheck or approved equal.

- B. The prewired control center shall include an integral master disconnect switch with fuse blocks for main power connection, magnetic motor starters for supply fans with thermal overloads and manual reset, fused 120 volt control transformer and distribution terminal control strip for control wiring connection. All components shall be U.L. Listed, and suitable for outdoor use. All wiring shall be complete, requiring only single point power connection and one point of connection for low voltage. Interlock supply fan with respective exhaust fan.
- C. Where noted provide tempered make-up air. Tempered make-up air unit shall include, in addition to above, an indirect gas-fired heating section. Indirect gas heater shall be A.G.A. certified and include heavy duty stainless steel heat exchanger, removable aluminized steel burners with stainless steel ribbons, pilot assembly, slide out burner tray, and gravity venting system. Controls shall include a main gas pressure regulator, main modulating gas valve, electronic spark ignition, safety pilot, high limit and 24-volt control transformer.

2.21 GAS-FIRED CABINET UNIT HEATER

- A. Heaters shall be UL Listed for cabinet and duct-connected application with capacities, voltages, mounting arrangements and control options as specified in schedule. Units shall be Reznor or approved equal, commercial quality with heavy duty 16 gauge cabinet, minimum radius edges and stiffeners on grilles and panels for extra strength. Cabinet to be phosphatized and finished with baked-on neutral beige combination primer/finish.
- B. Fan housing with single or double shaft motor and blower shall be mounted as a removable assembly. Fan wheel and streamlined die-formed inlets shall be engineered for minimum noise level.
- C. Gas-fired Furnace: Natural gas fired, self-contained, complete with burner and controls, AGA certified, aluminized steel heat exchanger, electronic ignition, minimum AFUE efficiency of 80 percent.
- D. Terminals accept one power source for connection to 120V wire units with integral thermostat. Suitable for copper wire, sized at 125% of rated load per NEC.

PART 3 - EXECUTION

3.1 INSTALLATION OF SHEET METAL WORK

- A. General: All necessary allowance and provisions shall be made in the installation of sheet metal ducts for the structural conditions of the building, and ducts shall be transformed or divided as may be required at no change in contract price. Whenever this is necessary, the required area shall be maintained. All of these changes, however, must be accepted and installed as directed at project. During the installation the open ends of ducts shall be protected to prevent debris and dirt from entering.
- B. Whenever exposed ducts pass through walls, floors, or ceilings, a flanged sheet metal collar fitting close around ducts shall be slipped along duct until flange is tight against finished surface covering edges of openings and presenting a neat appearance. Collar shall be locked to duct.
- C. Ductwork is frequently routed through bar joists and between bar joists. Contractor shall coordinate duct locations with joist submittals prior to fabrication.
- D. Contractor shall submit fabrication drawings of not less than 1/4" scale for approval prior to fabrication.

3.2 CLEANING

- A. All ducts, coils, housing, registers, grilles, fans, etc., shall be clean when installed and shall be kept clean until the system is completed. As the various parts of the system are installed, they shall be wiped or blown clean and openings taped dust-tight with heavy paper or cardboard until the system is completed and ready for testing. At that time all covers and protective wrappings shall be removed. Where one has been torn or previously removed, the duct, coil, register, etc., shall be carefully cleaned of any dirt or dust that has entered the opening. Open ends of all ductwork shall be closed off with plastic during construction to minimize dust and litter accumulation.

3.3 DUCT PENETRATIONS

- A. Where ducts are shown connecting to masonry openings and along edges of all plenums at floors and walls, provide a continuous 2" x 2" x 1/8" galvanized angle iron which shall be bolted to the construction and made airtight to the same by applying caulking compound. Sheet metal in these locations shall be bolted to the angle iron. Seal fire and/or smoke wall and all floor penetrations with Dow Corning, or equivalent, 3-6548 Silicone RTV foam.

3.4 FLEXIBLE CONNECTIONS

- A. Provide flexible connections, not less than 4" wide, constructed of heavy waterproof woven plastic coated glass fabric at locations indicated on the drawings and at the inlet and outlet connection at each fan unit where directly connected to duct system. Flexible connections shall be securely fastened to the equipment and to the ductwork by a galvanized iron band, provided with tightening screws. Fabric for flexible connections used in special exhaust systems shall be compatible for service. Provide steel spring vibration isolators spanning across flexible connections of isolated fan housings to prevent blow-apart horizontal displacement of fan housings. Flexible connections exposed to the ultra violet rays of the sun shall be equivalent to Ventlon as manufactured by Ventfabrics, Inc.

3.5 HAND DAMPERS

- A. Install hand operated volume dampers at locations and of sizes shown and/or as required for proper balancing. Volume dampers shall be controlled by heavy duty locking quadrants mounted on the outside of the duct. Where ducts are insulated, the damper rod shall be extended and the operator shall be mounted on the outside of the insulation. Splitter dampers shall be at least 1-1/2 times as long as the narrowest adjacent split. All damper fittings must be heavy commercial items and must be accepted by the Architect before installation.
- B. Supporting dampers: Dampers shall be supported by properly reinforcing the ductwork or sheet metal walls at the damper locations to carry the weight of the dampers and the force exerted on the dampers due to air pressure, or shall be supported independent of ductwork from the ceiling or floor, as conditions at the site determine. Damper frames shall be bolted - not welded - to prevent frame distortion.

3.6 CROSS BREAKING

- A. Low velocity rectangular sheet metal ducts shall be cross broken on the four sides of each 4-foot panel. All vertical and horizontal sheet metal barriers, duct offsets, elbows, as well as 4-foot panels of straight sections of ducts shall be cross broken. Cross breaking shall be applied to the sheet metal between the standing seams or reinforcing angles; the center of cross break shall be of the required height to assure surfaces being rigid.

3.7 TEST HOLES IN DUCTWORK

- A. Furnish test holes in ducts at locations required by the Testing and Balancing Team for testing of air quantities in ducts. Ventlok No. 699 or accepted equivalent closures shall be provided and installed for each test hole, with sufficient neck length to penetrate the insulation.

3.8 HANGERS AND SUPPORTS

- A. It is essential that all ducts shall be rigidly supported. Hangers shall be per the 2009 IMC and SMACNA Standards. Where vertical ducts pass through floors or roofs, heavy supporting angles shall be attached to ducts, and to structure. Angles shall be of sufficient size to support the ductwork rigidly and shall be placed on at least two sides of the duct.
- B. Construct hangers for rectangular ductwork from galvanized iron per the 2009 IMC and SMACNA standards. Hangers shall extend down the sides of rectangular ducts the full depth of the duct and shall be bent underneath the duct 2". Hangers shall be secured to the duct using sheet metal screws or rivets of appropriate sizes on 6-inch centers, but not less than two screws in the side and one on the bottom of each hanger.

3.9 V-BELT FAN DRIVES

- A. Furnish and install new sheaves, pulleys and belts, and readjust drives, if necessary, to obtain the scheduled air flows of adjustable drive fans.

3.10 CONDENSATE DRAIN LINES

- A. Install condensate drain pipes from air handling unit drain pan to designated location shown on drawings. Provide minimum 1/8 inch per foot slope on all horizontal pipes.

END OF SECTION

SECTION 25 00 00

BAS Instrumentation and Control

PART 1 - GENERAL

1.1 RELATED SECTIONS

- A. SECTION 23 09 93, BAS Sequences of Operations

1.2 REFERENCES

- A. American National Standards Institute (ANSI)
 - 1. ANSI/ISA 5.5-1985 Graphic Symbols for Process Displays.
 - 2. ANSI/IEEE 260.1 2004, Standard Letter Symbols for SI and Certain Other Units of Measurements (SI Units, Customary Inch Pound Units and Certain Other Units).
 - 3. ANSI/ASHRAE 135-2016, BACnet® - A Data Communication Protocol for Building Automation and Control Networks.

1.3 ACRONYMS, ABBREVIATION, AND DEFENITIONS

- A. Acronyms used in BAS.
 - 1. BAS – Building Automation System
 - 2. EMCS – Energy Management and Control System
 - 3. GUI – Graphical User Interface
 - 4. HVAC - Heating, Ventilation, Air Conditioning
 - 5. I/O - Input/output
 - 6. ISA - Industry Standard Architecture
 - 7. O&M - Operation and Maintenance
 - 8. Niagara4 – Software framework for building device-to-enterprise applications and Internet-enabled products.

1.4 STANDARDS COMPLIANCE

- A. All equipment and material to be from manufacturer's regular production, UL and/or ULC or CSA certified, manufactured to standard quoted plus additional specified requirements.
- B. Where UL and/or ULC or CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
- C. Additional applicable codes and standards:
 - 1. National Electrical Code -- NFPA 70.
 - 2. Local Electrical Codes
 - 3. Federal Communications Commission -- Part J.

1.5 WORK INCLUDED

- A. Provide a new building system to control and monitor the building's mechanical and electrical systems.
- B. Provide control valves, control damper actuators / end switches (gravity, fire and smoke control dampers by others), flow switches, thermal wells for temperature control, air flow stations, and other control devices as necessary.

- C. Provide submittal data sheets, control drawings schematics (in Visio or AutoCAD), data entry, electrical installation, programming, start up, test and validation acceptance documentation, as-built documentation, maintenance manuals and system warranties.
- D. All labor, material, equipment and services not specifically referred to in this specification or on associated drawings that are required to fulfill the functional intent of this specification shall be provided at no additional cost to the Owner.
- E. The work covered by this specification and related sections consists of providing submittals, labor, materials, engineering, technical supervision, and transportation as required to furnish and install a fully operational BAS to monitor and control the facilities listed herein, and as required to provide the operation specified in strict accordance with these documents, and subject to the terms and conditions of the contract. The work in general consists of but is not limited to, the following:
 - 1. Furnish and install all to achieve system operation, any control devices, conduit and wiring, in the facility as required to provide the operation specified.
 - 2. Furnish complete operating and maintenance manuals and field training of operators, programmers, and maintenance personnel.
 - 3. Perform acceptance tests and commissioning as indicated.

1.6 WORK BY OTHERS

- A. Setting in place of valves and dampers, access doors, flow meters, water pressure and differential taps, flow switches, thermal wells, air flow stations, and current transformers shall be by others.
- B. Duct smoke detectors, smoke dampers, fire/smoke dampers, and associated actuators / end switches shall be provided under another Division of this specification. The Division 26 electrical contractor shall interlock these devices to the BAS for shutdown/monitoring unless otherwise outlined in the Sequences of Operations for this project. The BAS contractor shall coordinate where to land wires and programming as needed.
- C. Switches, and power wiring to motors, starters, thermal overload switches, and contactors, is specified under another Division of this specification.

1.7 BAS OPEN SYSTEM DESIGN AND QUALIFICATIONS

- A. Open System Design: It is the owners expressed goal to implement an open Building Automation System that will allow products from different manufacturers and/or suppliers to be integrated into a single unified system in order to provide flexibility for expansion, maintenance, and service of the system. The BAS manufacturer / contractor must provide proof of open system design as outlined below.
- B. Prior to award of the contract the BAS contractor is to provide proof of "Open System Design" with the following requirements:
 - 1. Provide proof of having a local office within 50 miles [80 km] of project for at least 5 years, staffed by trained personnel capable of providing installation, engineering, programming, servicing, commissioning, instruction, routine maintenance, and emergency service on systems.
 - 2. The controls system shall utilize the Niagara4 software framework.
 - a. The Contractor shall have a minimum of 2 years' experience in the sales, installation, engineering, programming servicing and commissioning of Niagara4.

- b. Submit the Niagara Compatibility Statement (NiCS) via a letter from the manufacturer. The NiCS shall have no connectivity restrictions and all aspects of the Niagara Framework will be provided to maintain an Open System Design. The System as provided shall confirm with the following NiCS properties (Station Compatibility In, Station Compatibility Out, Tool Compatibility In, AND Tool Compatibility Out shall each have a value of "All").
- 3. The controls system shall conform to the following guidelines for communication protocols.
 - a. BACnet shall be used for all BAS provided controllers.
 - 1) The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International and all controllers used shall be BACnet Listed with documentation on the BACnet website (<https://www.bacnetinternational.net/btl/search.php>)
 - 2) The use of BACnet Communications protocol alone shall NOT warrant an "Open System Design." Manufacturers must adhere to all aspects of "BAS Open System Design and Qualifications" and "Acceptable System Manufacturers" sections to comply.
 - b. Modbus shall only be acceptable for third party devices.
 - c. LonTalk shall only be acceptable for sites with existing LonTalk controls architecture where the owner has explicitly stated that the LonTalk architecture must remain in place.
 - d. Proprietary communications protocols shall NOT be acceptable.
- 4. A software programming tool shall be provided for this project and adhere to the following guidelines:
 - a. All software tools needed for full functional use, including programming of controllers, Niagara4 Framework network management and expansion, and graphical user interface use and development, of the BAS described within these specifications shall be provided to the owner or his designated agent.
 - b. The software programming tool shall be free of charge and openly available for download from the internet.
 - c. For any manufacturer that does not have a free programming tool the manufacturer must provide the tool with this project for a minimum of 5 years with proof of availability via letter from the manufacturer.
 - d. Any licensing required by the manufacturer now and to the completion of the warranty period, including changes to the licensee of the software tools and the addition of hardware corresponding to the licenses, to allow for a complete and operational system for both normal day to day operation and servicing shall be provided.

PART 2 – PRODUCTS

2.1 ACCEPTABLE SYSTEM MANUFACTURERS AND CONTRACTORS

- A. Provide a building automation system supplied by a company regularly engaged in the manufacturing and distribution of building automation systems for a minimum of 5 years.
- B. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.
- C. BACnet/IP communication protocol must be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, FCUs, etc.)
- D. Any approved manufacturer that can supply both equipment and controls must provide controls pricing separately from equipment pricing.
- E. Acceptable Manufacturers
 - 1. BAS Controls by Climatec
 - 2. Carrier by Sigler
 - 3. Trane Controls
 - 4. Circon by Mechanical Products BAS
 - 5. Delta by Arizona Control Specialists

2.2 QUALITY ASSURANCE

- A. All new building automation system products on this project shall be provided by a firm that is a registered ISO 9001:201508 manufacturer, for a minimum duration of 5 years, at time of bid.

2.3 COMPUTER HARDWARE

- A. Provide the following computer hardware for this project:
 - 1. Workstation Computer(s) [Typical of 1]
 - 2. Uninterruptable Power Supplies
- B. Server Hardware Requirements
 - 1. The Server shall adhere to the following minimum requirements: the latest generation Intel Core i5 processor, 16 GB RAM, and a 1TB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), VM support, and an ethernet adapter (10/100MB with RJ45 connector). Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.
 - 2. The server shall support all network/building controllers, OWSs, and 3rd party mechanical / electrical systems connected to the Facility Management Control / Building Automation System Local Area Network.
 - 3. Acceptable Manufacturers are:
 - a. Dell
 - b. Lenovo
 - HP (Hewlett Packard)

C. Workstation Hardware Requirements

1. The Workstation shall adhere to the following minimum requirements: the latest generation Intel Core i5 processor, 8 GB RAM, and a 500GB solid state hard drive. It shall include the latest Windows 64-bit operating system (Windows 10 pro or newer), Microsoft Office programs, VM support, an ethernet adapter (10/100MB with RJ45 connector), 32X CD-ROM drive, and 2-USB ports.
- 2.. A minimum 21", HDMI, DVI-D video interfaces, minimum 1024 x 768 resolution, 4x3 Widescreen, LED color monitor with a minimum 60 Hz refresh rate shall also be included.
3. A mouse and keyboard shall be provided.
4. Connection to the BAS LAN network shall be via an Ethernet network interface card, 100 Mbps.
5. Workstation(s) should be loaded with Programming Tools
6. Acceptable Manufacturers are:
 - a. Dell
 - b. Lenovo
 - c. HP (Hewlett Packard)

D. Uninterruptable Power Supplies

1. Provide the OWS, Server, and each network/building controller with individual UPS to provide clean, reliable, noise-filtered power at all times and to protect and maintain systems operation throughout short term power interruptions of up to 15 minutes duration.
2. Acceptable Manufacturer is APC.

2.4 REMOTE ACCESS AND CYBER SECURITY BEST PRACTICES

A. Remote Access

1. The BAS contractor shall comply with owner IT infrastructure security policies for remote access. The owner IT team shall provide VPN, firewalls, etc. as needed for secure remote access.
2. A VPN and firewall must be used for secure remote access.

B. Cyber Security Best Practices

1. Unless predetermined by the owner IT team the BAS network shall be separate from the owners IT infrastructure besides a single point connection for remote access (owner provided internet access). All ethernet switches and communication backbone required for a fully operational BAS shall be provided by the BAS contractor.
2. Refer to "Communication Backbone" section of this specification for further details on segmenting the network (VLANs, subnets) and when edge or managed switches are required based on building size / type.
3. Do not use factory provided usernames and passwords. Update passwords and usernames regularly for strong system security.
4. Update software and firmware regularly.
5. Adhere to controls manufacturer hardening guidelines where applicable.

2.5 OPERATOR SOFTWARE

A. Real-Time Displays

1. Provide a visual graphical representation of buildings, floor layouts, each piece of mechanical equipment and/or mechanical system that duplicates the represented system, presented as a web page via any industry standard web browser, where applicable.
2. Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs.

B. On-Line Help

1. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system.

C. Security

1. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data.
2. System security shall be selectable for each operator.
3. The system administrator shall have the ability to set passwords and security levels for all other operators.
4. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object.
5. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected.
6. This auto log-off time shall be set per operator password.
7. All system security data shall be stored in an encrypted format.

D. System Diagnostics.

1. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers.
2. The failure of any device shall be annunciate to the operator.

E. Third-Party Windows-Based Programs

1. The system shall be capable of utilizing third-party Windows-based programs for such things as spreadsheet analysis, graphing, charting, custom report generation, and graphics design packages.
2. Graphics generation shall be done using standard Windows packages.
3. No proprietary graphics generation software shall be needed.

F. Overrides

1. It shall be possible for the operator to override automatic analog and digital output commands.
2. Where the BAS software normally originates these outputs, the provision shall exist for the operator to terminate automatic BAS control of any particular output and to originate a manual analog or digital output command.
3. The provision shall exist for the operator to return analog or digital output command functions to automatic BAS software control.

G. Password Protection

1. Provide security system that prevents unauthorized use unless operator is logged on.

H. Trend Data

1. System shall periodically gather historically recorded selected samples of object data stored in the field equipment (global controllers, field controllers) and archive the information on the operator's workstation (server) hard disk.
 - a. Archived files shall be appended with new sample data, allowing samples to be accumulated over 3 years.
 - b. Systems that write over archived data shall not be allowed, unless limited file size is specified.
 - c. Samples may be viewed at the operator's terminal in a trend log.
 - d. Logged data shall be stored in spreadsheet format.
 - e. Operator shall be able to scroll through all trend log data.
2. Software shall be included that is capable of graphing the trend logged object data. Software shall be capable of creating two-axis (x,y) graphs that display up to six object types at the same time in different colours and these Graphs shall show object type value relative to time.
3. Operator shall be able to change trend log setup information such as time intervals and objects logged.

I. Graphics

1. The operator's workstation shall display all data associated with the project.
 - a. Operator's workstation shall display all data using 3-D graphic representations of all mechanical equipment.
2. System shall be capable of displaying graphic file, text, and dynamic object data together on each display.
 - a. Information shall be labelled with descriptors and shall be shown with the appropriate engineering units.
 - b. All information on any display shall be dynamically updated without any action by the user.
 - c. Terminal shall allow user to change all field-resident BAS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc. from any screen no matter if that screen shows all text or a complete graphic display.
3. Animated graphic objects shall be displayed as a sequence of multiple bitmaps to simulate motion.
4. Analog objects may also be assigned to an area of a system graphic, where the colour of the defined area would change based on the analog objects value.
 - a. For example, an area of a floor-plan graphic served by a single control zone would change colour with respect to the temperature of the zone or its deviation from setpoint.
5. Separate Displays shall be supplied, specific to the project, to form the following overall presentation style.
6. All Displays will be linked in a logical fashion using hyperlink style (single left mouse click on text/display object/dynamic to load linked display if programmed)
7. Entire system shall operate without dependency on the operator's terminal. Provide graphic generation software at each workstation.

J. Alarms

1. Operator's terminal shall provide audible, visual, electronic and printed means of alarm indication.
2. Any alarm may be handled based on its individual or assigned class actions.
 - a. Displayed on the Alarm console.
 - 1) The system shall be provided with a dedicated alarm window or console.
 - 2) This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm.
 - b. Alarm reports shall be viewable via the BAS system and available for delivery by electronic mail (e-mail) or printing.
3. System shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the system operator's terminal.
 - a. Each entry shall include a description of the event-initiating object generating the alarm, time and date of alarm occurrence, time and date of object state return to normal, and time and date of alarm acknowledgement.

K. Scheduling

1. Operator's terminal display of weekly schedules shall show all information in easy-to-read 7-day (weekly) format for each schedule.
2. Exception schedules (non-normal schedules, such as holidays or special events) shall display all dates that are an exception to the weekly schedules.
3. At the operator's terminal, the system user shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate security access.

L. Archiving

1. Store back-up copies of all controller databases in at least one OWS and the server.
2. Provide continuous supervision of integrity of all controller databases.
3. Data base back up and downloading to occur over LAN without operator intervention.
4. Operator to be able to manually download entire controller database or parts thereof.

M. Reports

1. Provide a report facility to generate and format for display, printing, or permanent storage, as selected by the operator, the reports as specified in this section.
2. Provide the software to automatically generate any report specified; the user will be able to specify the type of report, start time and date, interval between reports (hourly, daily, weekly, monthly) and output device.
3. As a minimum, the following reports shall be configured on the system:
 - a. Dynamic Reports: To allow operator to request a display of the dynamic value for the user specified points which shall indicate the status at the time the request was entered and updated at an operator modifiable scan frequency.
 - b. Summary Report: To permit the display or printing of the dynamic values for the user specified points.
 - c. Trend Reports: To permit the trending of points selected by the operator, including as a minimum digital input and output, analog input and output, set points, and calculated values.
 - d. Historical Data Collection: Provision shall be made to ensure historical data is not lost.

- e. Alarm Summary: Provide a summary of all points in alarm and include as a minimum; point acronym, point description, current value, alarm type, limit exceeded, and time and date of occurrence.
- f. Disable Point Summary: Provide a summary of all points in the disabled state and include as a minimum point acronym and point description.
- g. Run Time Summary: Provide a summary of the accumulated running time of selected pieces of equipment with point acronym and description, run time to date, alarm limit setting. The run time shall continue to accumulate until reset individually by means of suitable operator selection.
- h. Schedule Summary: Provide a summary of all schedules and indicate as a minimum, which days are holidays and, for each section, the day of the week, the schedule times and associated values; for digital schedules value will be on or off; for analog schedules value will be an analog value.
- i. User Record Summary: Provide a summary of all user records to include as a minimum; user name, password, initials, command access level and point groups assigned.

2.6 BAS CONTROLLERS

A. All controllers on the job shall have the following minimum requirements:

1. IP Communication (BACnet/IP)
 - a. BACnet/IP communication protocol shall be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, FCUs, etc.)
 - b. Support for IPv4 addressing
 - c. DHCP support and Auto DNS
 - d. Baud rate of not less than 100 Mbps
 - e. 2 - RJ45 ports each capable of supporting 10/100 Base-T.
 - 1) Supporting controller daisy chaining on the Ethernet network via integral switch functionality.
 - 2) Integrated fail-safe should allow for communication when the controller is powered down.
 - f. All controllers shall be able to communicate peer-to-peer without the need for a Network Control Unit (such as JACE, NAE, etc.) and shall be capable of assuming all responsibilities typically assumed by a Network Control Unit.
 - 1) Any controller on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
 - 2) The resulting network will be a 'Flat' topology with all devices (controllers, workstations, ...) connecting at the same physical network level.
2. Memory and Processing
 - a. 512KB of RAM and 4GB of non-volatile flash memory.
 - b. 32-bit microprocessor operating at a minimum of 600 MHz.
3. Each individual controller shall have an embedded web-based HTML5 visual interface with the following functionality without reliance on any other controller for access:
 - a. Typical and custom control processes
 - b. Scheduling
 - c. Energy management applications

- d. Alarm management applications
 - e. Historical/trend data for points specified
 - f. Maintenance support applications
 - g. Graphical interface
4. Shall be capable of monitoring/controlling the following types of inputs/outputs:
- a. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - b. Analog inputs of 4-20 mA, 0-10 Vdc, thermistor and RTD in the range 0 to 350,000 ohm.
 - c. Digital outputs including Form C relay outputs and Triac outputs
 - d. Analog outputs of 4-20 mA and 0-10 Vdc.
 - e. A minimum of 10% spare capacity for each point type for future point connection.
5. Any software required for programming shall be unlicensed and openly available
6. Auto commissioning features shall be available for VAVs and FCUs to schedule automatic testing and record values (air flows, pressures, temperatures, etc.) for different operating modes. The auto commissioning feature shall be able to email reports and run commissioning on a specified schedule.
7. Power and Environmental Requirements:
- a. 24 VAC with local transformer power
 - b. The controllers shall also function normally under ambient conditions of -32 °F [0 °C] to 122 °F [50 °C] and 0% to 90% RH (non-condensing).
 - c. Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.
8. Code Compliance:
- a. "FIPS 140-2 Level 1 Compliant" cryptographic module
 - b. BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
 - c. UL916 Energy management equipment
 - d. FCC rules part 15, subpart B, class B
 - e. UL94-V0 flammability rating

2.7 CONTROL PANELS

- A. Indoor control cabinets located in offices or dry/dust free environments shall be fully enclosed NEMA 1 Type construction with hinged door, and removable sub-panels or electrical sub-assemblies.
- B. All outdoor control cabinets and control cabinets located in mechanical/electrical rooms shall be NEMA 4.
- C. Control panels containing more than 4 controllers shall be provided with a terminal strip for field wiring. All control wiring inside the panel shall be between a terminal strip and controller inputs/outputs. All field control wiring shall be terminated at the terminal strip. Field control wiring inputs/outputs shall never be run directly to inputs/outputs of controller.

2.8 AUTOMATIC CONTROL DAMPERS

- A. Provision of dampers shall be provided by another section of this specification (the BAS contractor shall only be responsible for providing actuators/end switches for control dampers).

2.9 VARIABLE FREQUENCY DRIVES (VFDS)

- A. Provision of variable frequency drives shall be provided by another section of this specification (the BAS contractor shall only be responsible for providing associated low voltage wiring and controls programming for the VFDS).

2.10 AUXILIARY CONTROL DEVICES, SENSORS, AND TRANSMITTERS

A. Control Valves

1. Zone Control Valves (On/Off, Two-Position Applications):

- a. Zone Valve (valves 1" [25 mm] and smaller): Forged brass body, rated at no less than 300 psi,[2070 kPa] female NPT union or sweat with a stainless steel stem and EPDM seals.
- b. Sizing:
 - 1) Two-Position: Line size or size using a pressure differential of 1 psi.[7 kPa]
- c.. Close-off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of total system head pressure for 2-way valves and 125% of the design pressure differential across the 3-way valves.
- d. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory.
- e. Power Requirements: 24 VAC or 24VDC

2. Acceptable Manufacturers:

- a. Belimo
- b. Bray

B. Damper Actuators

1. Features:

- a. Electronic Damper Actuators: Actuators shall be sized for torque required for sealing the damper at load conditions, shall utilize v-bolt dual nut clamp with v-shaped tooth cradle coupling, and shall be capable of being mechanically or electrically paralleled to increase torque if required. Electronic overload protection or digital rotation-sensing circuitry shall be used to prevent any damage to the actuator during a stall condition (and shall not require the use of end switches for protection). Fail-safe operation shall be provided as mechanical spring return (or electrical if spring return is not available for actuator size).
- b. Terminal Unit Actuators: Actuators shall be sized for torque required for sealing the damper at load conditions and shall utilize V-bolt dual nut clamp with a V-shaped toothed cradle or an ISO-style direct-coupled mounting pad coupling. Close of differential pressure rating of 200psi.

2. Operating Temperature: -22° F to 122° F (-30° C to 50° C)

- 3. Protection / Rating: Minimum requirement NEMA type 2 / IP54 mounted in any orientation, NEMA 4X for outdoor applications, and UL94-5V(B) flammability for terminal unit actuators

4. Input/Output:
 - a. Two Position: Digital output including Form C relay output
 - b. Modulating: 4-20 mA and 0-10 Vdc.
 - c. End Switches / Auxiliary Switches (if applicable): SPDT, digital inputs from dry contact closure
 5. Power:
 - a. Electronic Damper Actuators: Two position spring return shall be 24 or 120VAC as required by manufacturer and proportional actuators shall be 10VA at 24VAC or 8W at 24VDC
 - b. Terminal Unit Actuators: maximum of 1 VA at 24VAC or 1 W at 24VDC
 6. Agency Approvals:
 - a. Electronic Damper Actuators: ISO 9001, UL, UL(C) and CSA C22.2 No. 24-93.
 - b. Terminal Unit Actuators: CE, UL 60730-1A/-2-14, CAN/CSA E60730-1, CSA C22.2 No. 24-93, CE according to 89/336/EEC.
 7. Approved Manufacturers / Models:
 - a. Belimo
- C. Air Pressure Sensor – Duct / Space / Air Differential (Filter/Coil Monitoring)
1. Features: Provide air pressure sensors as indicated within the sequences of operations and/or controls diagrams suitable for application. Select range as detailed below based on application type. Sensor shall include over pressure input protection of a minimum two times rated input or 20 psi (whichever is greater).
 - a. Duct Mounted Static Pressure Sensor: Select range such that it covers from zero duct static pressure relative to the exterior of the duct up to a static pressure of between 20% and 50% in excess of the maximum static pressure that could be encountered in the duct relative to the duct exterior. Typically, for low pressure commercial duct consider using a range of 0 to 2" wc. (0 to 500Pa), for medium pressure duct use a range of 0 to 6" wc. (0 to 1500Pa) and for high-pressure duct use a range of 0 to 10" wc (0 to 2500 Pa).
 - b. Space Static Pressure Sensor: Input range of -0.2" to + 0.2" wc (-50 to +50 Pa).
 - c. Air Differential Pressure Sensor: Select range as required, taking into consideration pressure drop across filter or coil. Typically 0-2" wc (0 to 500 Pa) range for low-pressure commercial duct.
 2. Operating Temperature: 32° F to 140° F (0° C to 60° C)
 3. Protection / Rating: Polycarbonate (UL 94 V-0 Approved)
 4. Input/Output: 4-20 mA, 0-5V, or 0-10V output proportional to pressure sensed
 5. Power: 24VAC or 24VDC
 6. Accuracy: $\pm 1\%$ of full scale
 7. Range: selectable pressure range 0- 20" w.c.
 8. Agency Approvals: UL listed
 9. Approved Manufacturer / Model:
 - a. Setra

D. Air Pressure Switch

1. Features: Provide air pressure switches as indicated within the sequences of operations and/or controls diagrams suitable for application. Select range as required, taking into consideration pressure drop across filter or coil. Typically 0.2-2" wc (0 to 500pa) range for low-pressure commercial duct. Sensor shall include over pressure input protection of a minimum two times rated input or 20 psi (whichever is greater).
2. Operating Temperature: -4° F to 140° F (-20° C to 60° C)
3. Protection / Rating: IP54 (NEMA 13) polycarbonate
4. Input/Output: SPDT switch digital input from dry contact closure
5. Power: N/A
6. Accuracy: $\pm 1\%$ of full scale
7. Range: selectable pressure range 0- 12" w.c.
8. Agency Approvals: N/A
9. Approved Manufacturer / Model:
 - a. Setra

E. Gas Sensor and Control System

1. Features: Self-contained dual gas sensor that is network ready for either peer-to-peer (master slave) operation or central control for a smooth integration into new or existing energy management system. Impact resistant water proof enclosure, 3 adjustable alarm relays, indicators and strobe (Red LED alarm indicators, level 1 and 2 High intensity white LED strobe and audible alarm on level 3). The sensor shall include an 85db audible alarm and LCD display for calibration, user settings, and displaying gas concentrations. Sensor shall be placed in locations outlined within sequences of operations, mechanical plans, and/or control diagrams. Mounting heights and distance covered shall also adhere to manufacturer recommendations. Sensor shall be factory calibrated and will only require calibration after a minimum one (1) year service.
2. Operating Temperature: -4° F to 104° F (-20° C to 40° C)
3. Protection / Rating: ABS UL-94-V0, UL-94 - 5VA, Nema 4
4. Input/Output:
 - a. 4-20 Ma or 2-10V analog output
 - b. 2 Relays SPDT, 5 amp @ 125 vac, non-inductive
 - c. RS-485 serial interface BACnet MS/TP
5. Power: 24 V AC
6. Accuracy: $\pm 2\%$ of full scale
7. Range: ppm or %LEL based on manufacturers recommendations
8. Agency Approvals: UL61010-1, CSA C22.2 61010-1-12, ANSI/ISA 61010-1, CSA C22.2 no. 205-12.
9. Approved Manufacturer / Model:
 - a. Honeywell Vulcane
 - b. Approved Equal

F. Air Quality Sensor

1. Features: Air quality sensor that is able to detect poor air quality from a broad range of volatile organic compounds (VOCs) such as cooking odors, smoke, bioeffluence, outdoor pollutants and from human activities. The air quality sensor shall detect volatile organic compounds beyond typical CO2 applications. Sensor shall be space mounted or duct mounted in locations outlined within sequences of operations, mechanical plans, and/or control diagrams.
2. Operating Temperature: 32° F to 122° F (0° C to 50° C)
3. Protection / Rating: Polycarbonate, UL94-V0, IP65 (NEMA 4X)

4. Input/Output:
 - a. 0-5V or 0-10V analog output
 5. Power: 24 V AC
 6. Accuracy: $\pm 2\%$ of full scale
 7. Range: 450-2000ppm CO2 equivalent
 8. Agency Approvals: UL94-V0
 9. Approved Manufacturer / Model:
 - a. Distech Controls (GS-2AQD) [duct mounted]
 - b. Distech Controls (GS-AQR) [wall mounted]
 - c. Approved Equal
- G. Carbon Dioxide (CO2) Sensor
1. Features: Provide a space or duct carbon dioxide gas detection sensor as indicated within the sequences of operations and/or control diagrams. Optional features include BACnet communication, LCD display, setpoint adjustment, or integral temperature/humidity sensors (optional features shall be provided if necessary based on project scope).
 2. Operating Temperature: 32° F to 122° F (0° C to 50° C)
 3. Input/Output: 4-20 mA, 0-10 or 0-5 Vdc output compatible with BMS proportional to carbon dioxide concentration
 4. Power: 24VAC or 24VDC
 5. Accuracy: $\pm 3\%$ of full scale
 6. Range: 0 to 2000 ppm
- H. Duct / Immersion / Outdoor Temperature Sensors
1. Features: Provide Thermistor or RTD temperature sensors as indicated within the sequences of operations and/or control diagrams. Install sensor as detailed below.
 2. Outside Air Temperature Sensor: Provide outside air temperature sensors with Aluminum LB with PVC sun and windscreen weatherproof enclosure with conduit entrance. Install in an area where exhaust or roof heat will not affect readings.
 3. Duct Mounted Temperature Sensor (ducts less than 10ft² [1m²] in cross-sectional area): Provide duct mounted, single point probe temperature sensor with 0.25" [6.35 mm] stainless steel probe of length between one-third and two-thirds of the duct width.
 4. Duct Mounted Averaging Temperature Sensor (ducts greater than 10ft² [1m²] in cross-sectional area): Provide duct mounted, averaging, temperature sensor with probe length of 12 feet [3.66m] minimum or 1ft per ft² (3.25m per m²) of duct cross-sectional area, whichever is greater. Copper sheathed or plenum rated flexible construction.
 - a. Liquid Temperature Sensor: Provide immersion thermowell mounted temperature sensors for liquid temperature sensing. Rigid 0.25" [6.35mm] stainless steel probe of length, which is, at minimum, 20% of the pipe width. Provide Brass or Stainless steel thermowell (316 or 304) with thermal grease to aid temperature sensing.
 - b. Strap-on Temperature Sensor: Provide strap-on mounted temperature sensors where thermo well mounted sensors cannot be mounted.
 5. Operating Temperature: -58° F to 212° F (-50° C to 100° C) dependent upon application
 6. Input/Output: thermistor or RTD compatible with BAS
 7. Power: dependent upon sensor type – provide as per manufacturers recommendations
 8. Accuracy: $\pm 1.0^{\circ}\text{F}$ (0.5 °C)
 9. Range: -58° F to 212° F (-50° C to 100° C) dependent upon application

I. Duct / Outdoor Humidity Sensors

1. Features: Provide duct / outdoor humidity sensors as indicated within the sequences of operations and/or control diagrams. Outside air humidity sensors shall have ABS hinged weatherproof housing with conduit entrance and shall be installed in an area where exhaust or roof heat will not affect readings. Duct humidity sensors shall have ABS housing with conduit entrance. In addition all humidity sensors shall have 9" probe length, 60 micron HDPE filter, reverse voltage protection, and be output limited.
2. Operating Temperature: 32° F to 122° F (0° C to 50° C)
3. Input/Output: 4-20 mA two wires, 0-10 Vdc and/or 0-5 Vdc output proportional to relative humidity range of 0% to 100%
4. Power: 24VAC or 24VDC
5. Accuracy: $\pm 3\%$ of full scale
6. Range: 5-95%RH

J. Space Temperature Sensors

1. Features: Provide space temperature sensors as indicated within the sequences of operations and/or control diagrams. Shall consist of an element within a ventilated cover. Space sensors located in mechanical rooms and large public spaces shall contain a network jack, but shall have no ability to adjust temperature setpoint (Set Point Adjustment). Space sensors located in other spaces shall include options (setpoint adjustment, network jack, fan speed selection, override switch, and/or digital display) in accordance with the drawings and sequences of operations.
2. Operating Temperature: 32° F to 122° F (0° C to 50° C)
3. Input/Output: dependent upon sensor type – provide as per manufacturers recommendations
4. Power: dependent upon sensor type – provide as per manufacturers recommendations
5. Accuracy: $\pm 1.0^{\circ}\text{F}$ (0.5 °C)
6. Range: 32° F to 122° F (0° C to 50° C)

K. Space Humidity Sensors

1. Features: Provide space humidity sensors as indicated within the sequences of operations and/or control diagrams. Sensor shall have reverse voltage protection and be output limited.
2. Operating Temperature: 32° F to 122° F (0° C to 50° C)
3. Input/Output: dependent upon sensor type – provide as per manufacturers recommendations
4. Power: dependent upon sensor type – provide as per manufacturers recommendations
5. Accuracy: $\pm 3\%$ of full scale
6. Range: 5-95%RH

L. Combination Relative Humidity And Temperature Sensors

1. Where there is a requirement for the monitoring of both relative humidity and temperature at the same location, the BMS Contractor shall provide a combination relative humidity sensor and temperature sensor. The individual sensors must each meet the specifications details above.

M. Low Limit Thermostats

1. Features: Provide low limit thermostats as indicated within the sequences of operations and/or control diagrams. Safety low limit thermostats shall be vapor pressure type with an element 20 ft [6.1 m] minimum length. Element shall respond to the lowest temperature sensed by any one foot section. Low limit shall be manual reset only.
2. Operating Temperature: -60° F to 160° F (-51° C to 71° C)
3. Input/Output: 2 SPDT switches, digital inputs from dry contact closure

4. Power: N/A
5. Accuracy: $\pm 1.0^{\circ}\text{F}$ (0.5°C)
6. Range: adjustable range 34°F to 70°F (1°C to 21°C)

N. Current Relay/Switch

1. Features: Provide current sensing relays as indicated within the sequences of operations and/or control diagrams. The current sensing relay shall be rated for the applicable load, shall have input and output isolation via current transformer, and the output relay shall have an accessible trip adjustment over its complete operating range. Whenever the status of a single speed motor is monitored it shall be done via a current sensing relay. The BAS contractor shall provide current sensing relays at the MCC starters (or at the local starter for motors without a MCC starter).
2. Operating Temperature: 5°F to 140°F (-15°C to 60°C)
3. Input/Output: digital input from dry contact closure
4. Power: Current relay shall be self-powered with no insertion loss
5. Accuracy: $\pm 2\%$ of full scale

O. Current Sensor

1. Features: Provide current sensors as indicated within the sequences of operations and/or control diagrams. The current sensors shall be rated for the applicable load and shall be reverse polarity protected and output limited.
2. Operating Temperature: -20°F to 120°F (-29°C to 49°C)
3. Input/Output: 4-20 mA, 0-10 or 0-5 Vdc output proportional to current draw
4. Power: Current sensor shall be self-powered with no insertion loss
5. Accuracy: $\pm 1\%$ of full scale

P. Leak Detection Monitoring – Water

1. Features: Provide leak detectors as indicated within the sequences of operations and/or control diagrams. The appropriate leak detector type should be provided based on application (i.e spot leak detector for drain pans and rope leak detector for floors). Leak detectors shall be corrosion and abrasion resistant.
2. Operating Temperature: 50°F to 104°F (10°C to 40°C)
3. Input/Output: (2) Form C relays, digital input from dry contact closure
4. Power: 24 VAC

Q. Damper End Switch

1. Features: Provide damper end switches as indicated within the sequences of operations and/or control diagrams. End switches shall prove a damper has reached the position specified. End switches shall be integral to damper actuator unless otherwise specified.
2. Input/Output: SPDT switch, digital input from dry contact closure

PART 3 - EXECUTION

3.1 COMMUNICATION BACKBONE

- A. To allow for future expandability, cyber security measures, optimal bandwidth, and enhanced data trending this project shall adhere to the below communication backbone requirements.
- B. IP (CAT 5 / RJ45) Network
 - 1. Managed Ethernet Switches:
 - a. Required for all projects exceeding 5 levels (including rooftops/cellars) or 250 controllers and that do NOT meet or exceed "Fiber Optic Network" requirements described above.
 - b. Support for routing and VPN.
 - c. Acceptable Manufacturers:
 - 1) Teltonika
 - 2) Approved Alternate
 - 2. Unmanaged Ethernet Switches
 - a. Acceptable for all projects NOT exceeding requirements for "Fiber Optic Network" or "Managed Ethernet Switches" as described above.
 - b. Ethernet Switches shall be provided as needed to support a fully functional BAS – fiber network shall not be required.
- C. BACnet IP
 - 1. BACnet/IP communication protocol shall be used for all BAS manufacturer provided controllers (including terminal devices such as VAVs, FCUs, etc.)
- D. Modbus RTU and BACnet MS/TP (RS-485) Network
 - 1. Modbus RTU and BACnet MS/TP shall only be used for third party systems / equipment that do not have IP provisions (VFDs, boilers, etc.)
 - 2. Modbus TCP shall only be used for third party systems / equipment that do not support BACnet/IP

3.2 INSTALLATION OF SENSORS

- A. Install sensors according to manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for operating environment.
- C. Install mixing plenum low-limit sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 1 ft.[9 m] of sensing element for each 1ft² [1 m²] of coil area.
- D. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- E. Install outdoor air temperature sensors on north wall at designated location with sun shield.
- F. Install building pressure pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover.

- G. High and low limit thermostats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.3 CO-ORDINATION

- A. All work shall be performed at times acceptable to the Engineer/Construction Manager. Provide work schedule at the start of the job for the approval of the Engineer / Construction Manager. Schedule shall show when all staff and sub-contractors shall be on-site.

3.4 ELECTRICAL WORK, WIRING AND SAFETY

- A. Electrical work shall be in accordance ANSI/NFPA 70 and the local Electrical Code.
- B. Based on project location, Regional Regulation Compliance Certifications (CSA C22.1) will be required.
- C. Electrical wiring, terminal blocks and other high voltage contacts shall be fully enclosed or properly guarded and marked to prevent accidental injury to personnel.
- D. Control and interlock wiring and installation shall comply with national and local electrical codes, Division 26 00 00, and manufacturer's recommendations. Where the requirements of this Section differ from other Divisions, this Section shall take precedence.
 - 1. Power wiring to mechanical equipment, variable air volume boxes, and motor controllers shall be provided by the Electrical contractor (Division 26).
 - 2. EMT conduit shall be used in mechanical/electrical rooms and exposed spaces.
 - 3. Rigid Galvanized Steel conduit shall be used outdoors.
 - 4. Plenum rated cable shall be used in concealed spaces/hung ceilings.
- E. All wiring associated with and required by the BAS shall be the responsibility of this contractor.
 - 1. The term "wiring" shall be construed to include furnishing of wire, conduit, and miscellaneous material and labor as required to install a total working system.
 - 2. If departures from the contract documents are deemed necessary by the contractor, details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the drawings to the Engineer for approval.
- F. Terminate control and interlock wiring related to the work of this section. Maintain at the job site updated (as-built) wiring diagrams that identify terminations.
- G. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- H. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.
- I. Each run of communication wiring shall be a continuous length without splices when that length is commercially available.
- J. Label communication wiring to indicate origination and destination.

- K. Fiber optic cable shall comply with the following requirements:
1. Optical Cable. Optical cables shall be duplex 900 mm tight-buffer construction designed for intra-building environments. Sheath shall be UL listed OFNP in accordance with NEC Article 770. Optical fiber shall meet the requirements of FDDI, ANSI X3T9.5 PMD for 62.5/125 μm .
 2. Connectors. Field terminate optical fibers with ST type connectors. Connectors shall have ceramic ferrules and metal bayonet latching bodies.

3.5 SUBMITTALS

- A. Schematic diagram of each controlled system. Label control points with point names.
- B. Bill of Material for each controlled system. List each control system element in a table. Show element name, type of device, manufacturer, model number, and product data sheet number.
- C. Specification sheets for each item including manufacturers descriptive literature, drawings, diagrams, performance and characteristic curves, manufacturer and model number, size, layout, dimensions, capacity, etc.
- D. Control schematics with narrative description and control descriptive logic fully showing and describing operation and/or manual procedures available to operating personnel to achieve proper operation of the building, including under complete failure of the BAS.
- E. Shop drawings for each input/output point showing all information associated with each particular point including sensing element type and location; details of associated field wiring schematics and schedules; point address; software and programming details associated with each point; and manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter.
- F. Riser diagrams showing control network layout, communication protocol, and wire types.
- G. Network diagram of control, communication, and power wiring for BAS Server and OWS installation.

3.6 AS-BUILT DOCUMENTATION

- A. As-built documentation shall consist of 4 hard copies and one soft copy for all information described below.
- B. The final documentation package shall include:
 1. As-built Submittals: Final as built control submittals and technical data sheets.
 2. Programming, Sequences, and Graphics: All programming, sequences, and graphics saved to an external hard drive.
 3. Operation and Maintenance Manuals: Factory operating and maintenance manuals with any customization required.
 4. Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as test procedures.

3.7 WARRANTY

- A. The BAS system labor and materials shall be warranted free from defects for a period of 2 year(s) after final commissioning and owner acceptance.

3.8 TRAINING

- A. BAS Contractor shall provide a minimum of 16 hours of training with course outline and materials for personnel designated by the owner.
- B. If desired manufacturer provided training on the use and operation of all products provided within these specifications shall be available for purchase and attendance by the Owner or his designated agent. A list of training courses with detailed course outline and duration with the associated cost shall be provided as part of the BAS submittals.

3.9 BALANCING AND COMMISSIONING

- A. BAS Contractor shall provide a minimum of 16 hours of commissioning assistance with a commissioning agent and 16 hours of balancing assistance with a balancing agent. Balancing and commissioning agents shall NOT be provided by BAS contractor – BAS contractor is responsible for assistance only.
- B. For projects without balancing and commissioning agents the BAS contractor shall self commission the system utilizing the allotted hours stated above.
- C. For projects including gas detection / air quality sensors involved in life safety operations a minimum of 8 hours shall be provided within BAS scope of work for the gas sensor manufacturer to provide checkout, calibration, and owner training.
- D. Provide commissioning data sheets prior to acceptance testing.

3.10 ALTERNATES

- A. Maintenance Contract:
 - 1. The BAS Contractor shall present a two year maintenance contract for the Owner's acceptance within sixty days after installation of the system begins. Show the price for each year with all payment terms and conditions.
 - 2. The Maintenance Contract shall include the following provisions: on-line diagnostic and troubleshooting service, quarterly software maintenance/consultation/database backup, repair and replacement as needed (T&M proposals), and emergency service (per predetermined agreement).
 - 3. Maintenance Routines include, but are not be limited to the following: checking performance of equipment and components (with diagnostic testing, examination, adjustment, and calibration) and 2 training sessions per year.
 - 4. The Maintenance Contract shall be renewable at the Owner's option and include provision for increased charges due to expansion of the system, changes in service coverage, and/or inflation.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS – ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Grout.
 - 5. Common electrical installation requirements.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.

- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For sleeve seals.

1.5 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 will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

2.2 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.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL 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 piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetration unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- H. Seal space outside of sleeves with grout for penetration of concrete and masonry.
 - 1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 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 them in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V or less.
 - 2. Connectors, splices, and terminations rated 600 V or less.
 - 3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Alcan Products Corporation; Alcan Cable Division.
 - 2. General Cable Corporation.
 - 3. Senator Wire & Cable Company.
 - 4. Southwire Company.
- C. Copper Conductors: Comply with NEMA WC 70.
- D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW.

2.2 CONNECTORS AND SPLICES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AFC Cable Systems, Inc.
 - 2. Hubbell Power Systems, Inc.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M; Electrical Products Division.
 - 5. Tyco Electronics Corp.
- C. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.4 SLEEVE SEALS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
1. Advance Products & Systems, Inc.
 2. Calpico, Inc.
 3. Metraflex Co.
 4. Pipeline Seal and Insulator, Inc.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
- F. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- G. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- H. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- 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."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- 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 **12 inches** of slack.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- B. Concrete Slabs and Walls: Install sleeves for penetration unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. 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.
- D. Cut sleeves to length for mounting flush with both wall surfaces.
- E. Extend sleeves installed in floors 2 inches above finished floor level.
- F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.
- G. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to Division 07 Section "Joint Sealants."
- I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Division 07 Section "Penetration Firestopping."
- J. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.
- K. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- L. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.6 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground exterior-wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections and prepare test reports.
- C. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- D. 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.
- E. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

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SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes methods and materials for grounding systems and equipment plus the following special applications:
 - 1. Common ground bonding with lightning protection system.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - 1. Instructions for testing and inspection of grounding features at ground rings, grounding connections for separately derived systems based on NETA MTS and NFPA 70B.
 - a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

2.2 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Conductor Terminations and Connections:
 - 1. Equipment Grounding Conductor Terminations: Bolted connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
- C. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-1-1/2-by-12-inch grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Grounding Conductors: Route along the 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.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.
- B. Related Requirements:
 - 1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Hangers.
 - b. Steel slotted support systems.
 - c. Nonmetallic support systems.
 - d. Trapeze hangers.
 - e. Clamps.
 - f. Turnbuckles.
 - g. Sockets.
 - h. Eye nuts.
 - i. Saddles.
 - j. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
 - 1. Trapeze hangers. Include product data for components.
 - 2. Steel slotted-channel systems.
 - 3. Nonmetallic slotted-channel systems.
 - 4. Equipment supports.
 - 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Tube & Conduit.
 - 2. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 3. ERICO International Corporation.
 - 4. Thomas & Betts Corporation.

5. Unistrut; Tyco International, Ltd.
6. Or Approved Equal

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
 1. Material: Galvanized steel.
 2. Channel Width: 1-5/8 inches.
 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 4. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 7. Channel Dimensions: Selected for applicable load criteria.
- B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels, and angles with minimum 13/32-inch diameter holes at a maximum of 8 inches o.c., in at least one surface.
 1. Channel Width: 1-5/8 inches.
 2. Fittings and Accessories: Products provided by channel and angle manufacturers and designed for use with those items.
 3. Fitting and Accessory Materials: Same as those for channels and angles.
 4. Rated Strength: Selected to suit applicable load criteria.
 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Conduit and Cable Support Devices: 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 nonarmored 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. The body shall be made of malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 5) Or Approved Equal.
 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 where used.

- a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) 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.
 - 6) Or Approved Equal.
- 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
- 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural elements.
- 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: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.
- B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.
- D. 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.
- E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2- inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength

will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To New Concrete: Bolt to concrete inserts.
 - 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 3. 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.
 - 4. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 5. To Light Steel: Sheet metal screws.
- E. Drill holes for expansion anchor in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.

1.4 METAL WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper B-Line, Inc.
 - 2. Hoffman.
 - 3. Square D; Schneider Electric.
- C. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 3R, unless otherwise indicated.
- D. 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.
- E. Wireway Covers: Screw-cover type.
- F. Finish: Manufacturer's standard enamel finish.

1.5 BOXES, ENCLOSURES, AND CABINETS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. EGS/Appleton Electric.
 - 3. Erickson Electrical Equipment Company.
 - 4. Hoffman.
 - 5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
 - 6. O-Z/Gedney; a unit of General Signal.
 - 7. RACO; a Hubbell Company.
 - 8. Robroy Industries, Inc.; Enclosure Division.
 - 9. Scott Fetzer Co.; Adalet Division.
 - 10. Spring City Electrical Manufacturing Company.
 - 11. Thomas & Betts Corporation.
 - 12. Walker Systems, Inc.; Wiremold Company (The).
 - 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- C. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- H. Cabinets:
 - 1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet were required for freestanding equipment.

1.6 SLEEVES FOR RACEWAYS

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

1.7 SLEEVE SEALS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. Calpico, Inc.
 - 3. Metraflex Co.
 - 4. Pipeline Seal and Insulator, Inc.
- C. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
 - 1. 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.
 - 2. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 2 - EXECUTION

2.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
 - 1. Exposed Conduit: Rigid steel conduit, IMC, EMT.
 - 2. Concealed Conduit, Aboveground: Rigid steel conduit, IMC, EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 1, 3R, 4X
- B. Comply with the following indoor applications, unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT or RNC.
 - 2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 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.
 - 5. Damp or Wet Locations: Rigid steel conduit or IMC.
 - 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 3R or 4X in damp or wet locations.
- B. Minimum Raceway Size: 3/4-inch trade size.
- C. 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.

2.2 INSTALLATION

- A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- H. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- I. 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.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- L. Raceways for Voice/Data Outlets: Install raceways, metallic as follows:
 - 1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
 - 2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
 - 3. Install a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- M. 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. Where otherwise required by NFPA 70.

- N. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semi-recessed lighting fixtures, 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.
- O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall.

2.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."
- B. Concrete Slabs and Walls: Install sleeves for penetration unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- E. Cut sleeves to length for mounting flush with both surfaces of walls.
- F. Extend sleeves installed in floors 2 inches above finished floor level.
- G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- H. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."
- K. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

2.4 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install them in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

2.5 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

2.6 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Conduit, ducts, and duct accessories for concrete-encased duct banks, and in single duct runs.
 - 2. Handholes and boxes.

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 2. Warning tape.
- B. 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.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.6 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.

1.7 COORDINATION

- A. Coordinate layout and installation of ducts, 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 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.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ARNCO Corp.
 - 2. Beck Manufacturing.
 - 3. Cantex, Inc.
 - 4. CertainTeed Corp.; Pipe & Plastics Group.
 - 5. Condux International, Inc.
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Company.
 - 8. IPEX Inc.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT; a division of Cable Design Technologies.
- C. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-80-PVC[and Type DB-00 PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.
- D. Duct Accessories:
 - 1. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

2.3 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:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carder Concrete Products.
 - 2. Christy Concrete Products.
 - 3. Elmhurst-Chicago Stone Co.

4. Oldcastle Precast Group.
 5. Riverton Concrete Products; a division of Cretex Companies, Inc.
 6. Utility Concrete Products, LLC.
 7. Utility Vault Co.
 8. Wausau Tile, Inc.
- C. Comply with ASTM C 858 for design and manufacturing processes.
- D. 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. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC.", "TELEPHONE."
 6. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
 7. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 8. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - a. Type and size shall match fittings to duct or conduit to be terminated.
 - b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

2.4 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. 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:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carson Industries LLC.
 - b. Christy Concrete Products.
 - c. Utility Vault, a division of Oldcastle Precast

2.5 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. Tests of materials shall be performed by a independent testing agency.
 - 2. 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.
 - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.
- D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC installed in direct-buried duct bank, unless otherwise indicated.
- E. Underground Ducts for Telephone, Communications, or Data Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

3.2 EARTHWORK

- A. Excavation and Backfill: Comply with Division 22 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 topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turfs 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."

3.3 DUCT INSTALLATION

- A. Slope: Pitch ducts a minimum slope of 1:300 down toward 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.
- 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 Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 4-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to the handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical/Common Work Results for Communications/Common Work Results for Electronic Safety and Security."
- F. 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 (1.03-MPa) hydrostatic pressure.
- G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.
- H. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.4 INSTALLATION OF CONCRETE HANDHOLES, AND BOXES

- A. 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 (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
 - 1. Install handholes with bottom below grade.
 - 2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
 - 3. Where indicated, cast handhole cover frame integrally with handhole structure.

3.5 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 (12.7-mm) sieve to No. 4 (4.75-mm) 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 (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below grade.
- E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut the wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.6 GROUNDING

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 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.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Identification for conductors.
 - 2. Warning labels and signs.
 - 3. Equipment identification labels.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.
- C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustic ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 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.

2.2 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
- C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- E. Warning label and sign shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
 - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. The minimum letter height shall be 3/8 inch.
- B. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. The minimum letter height shall be 3/8 inch.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Power-Circuit Conductor Identification: For conductors in pull and junction boxes, handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- B. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

- C. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs or metal-backed, butyrate warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
 - 1. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door, or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- D. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
 - b. Outdoor Equipment: Engraved laminated acrylic or melamine label.
 - c. Elevated Components: Increase the sizes of labels and letters to those appropriate for viewing from the floor.
 - 2. Equipment to Be Labeled:
 - a. Panelboards, electrical cabinets, and enclosures.
 - b. Electrical switchgear and switchboards.
 - c. Transformers.
 - d. Disconnect switches.

3.2 INSTALLATION

- A. Verify the 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 non adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied or, for sizes larger than No. 8 AWG, field applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.

3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply the last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- H. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching controls.
4. Indoor occupancy sensors.
5. Outdoor motion sensors.
6. Lighting contactors.
7. Emergency shunt relays.

- B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 1. Interconnection diagrams showing field-installed wiring.
 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

- A. 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. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. Invensys Controls.
 4. Leviton Mfg. Company Inc.
 5. NSi Industries LLC; TORK Products.
 6. Tyco Electronics; ALR Brand.
 7. <Insert manufacturer's name>.
- C. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Contact Configuration: [SPST] [DPST] [DPDT]
 3. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac]
 4. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
 5. Programs: Each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
 6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
 7. Astronomic Time: Selected channels.
 8. Automatic daylight savings time changeover.
 9. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.
- D. Electromechanical-Dial Time Switches: Comply with UL 917.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Contact Configuration: [SPST] [DPST] [SPDT] [DPDT].
 3. Contact Rating: [30-A inductive or resistive, 240-V ac] [20-A ballast load, 120-/240-V ac].
 4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
 5. Astronomic time dial.
 6. Eight-Day Program: Uniquely programmable for each weekday and holiday.
 7. Skip-a-day mode.
 8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- 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. Cooper Industries, Inc.
 2. Intermatic, Inc.
 3. NSi Industries LLC; TORK Products.
 4. Tyco Electronics; ALR Brand.
- C. Description: Solid state, with **[SPST]** **[DPST]** dry contacts rated for 1800-VA tungsten or 1000-VA inductive to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range[, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off].
 3. Time Delay: Fifteen second minimum, to prevent false operation.
 4. Surge Protection: Metal-oxide varistor.
 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
- D. Description: Solid state, with **[SPST]** **[DPST]** dry contacts rated for 1800 VA, to operate connected load, complying with UL 773.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lux), with an adjustment for turn-on and turn-off levels within that range.
 3. Time Delay: Thirty-second minimum, to prevent false operation.
 4. Lightning Arrester: Air-gap type.
 5. Mounting: Twist lock complying with NEMA C136.10, with base.

2.3 DAYLIGHT-HARVESTING SWITCHING CONTROLS

- 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. Cooper Industries, Inc.
 2. Eaton Corporation.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. NSi Industries LLC; TORK Products.
 7. Sensor Switch, Inc.
 8. Tyco Electronics; ALR Brand.
 9. Watt Stopper.

- C. Ceiling-Mounted Switching Controls: Solid-state, light-level sensor unit, with separate power pack[**mounted on luminaire**], to detect changes in indoor lighting levels that are perceived by the eye.
- D. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 - 3. Sensor Output: Contacts rated to operate the associated power pack, complying with UL 773A. The sensor is powered by the power pack.
 - 4. Power Pack: Dry contacts rated for **20A** ballast load at 120- and 277-V ac, for **13-A** tungsten at 120-V ac, and for **1** hp at 120-V ac. The sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 - 5. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lux), with an adjustment for turn-on and turn-off levels within that range.
 - 6. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lux), with an adjustment for turn-on and turn-off levels within that range.
 - 7. Skylight Sensors Light-Level Monitoring Range: 1000 to 10,000 fc (10 800 to 108 000 lux), with an adjustment for turn-on and turn-off levels within that range.
 - 8. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
 - 9. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
 - 10. Test Mode: User selectable, overriding programmed time delay to allow settings check.
 - 11. Control Load Status: User selectable to confirm that load wiring is correct.
 - 12. Indicator: Two digital displays to indicate the beginning of on-off cycles.

2.4 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. B. 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. Cooper Industries, Inc.
 - 2. Hubbell Building Automation, Inc.
 - 3. Leviton Mfg. Company Inc.
 - 4. Lithonia Lighting; Acuity Lighting Group, Inc.
 - 5. Watt Stopper.
- C. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 - 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 - 2. System programming is done with two handheld, remote-controlled tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.

- D. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. The sensor is powered by a controller unit.
 3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
 4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc (120 to 640 lux).

2.5 INDOOR OCCUPANCY SENSORS

- 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. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. Lutron Electronics Co., Inc.
 8. NSi Industries LLC; TORK Products.
 9. RAB Lighting.
 10. Sensor Switch, Inc.
 11. Square D; a brand of Schneider Electric.
 12. Watt Stopper.
- C. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. The sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 5. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 7. Bypass Switch: Override the "on" function in case of sensor failure.
 8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lux); turn lights off when selected lighting level is present.

- D. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.
- E. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy .
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).
- F. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm) and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.6 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- 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. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lightolier Controls.
 6. Lithonia Lighting; Acuity Lighting Group, Inc.
 7. Lutron Electronics Co., Inc.
 8. NSi Industries LLC; TORK Products.
 9. RAB Lighting.
 10. Sensor Switch, Inc.
 11. Square D; a brand of Schneider Electric.
 12. Watt Stopper.

13. **<Insert manufacturer's name>.**
- C. General Requirements for Sensors: Automatic wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- D. Wall-Switch Sensor Tag WS1:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m) .
 2. Sensing Technology: PIR.
 3. Switch Type: [SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field selectable automatic "on," or manual "on" automatic "off."]
 4. Voltage: [Match the circuit voltage] [120 V] [277 V] [Dual voltage, 120 and 277 V]; [passive-infrared] [dual-technology] type.
 5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
- E. Wall-Switch Sensor Tag WS2:
1. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
 2. Sensing Technology: PIR.
 3. Switch Type: [SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field selectable automatic "on," or manual "on" automatic "off."]
 4. Voltage: [Match the circuit voltage] [120 V] [277 V] [Dual voltage, 120 and 277 V]; [passive-infrared] [dual-technology] type.
 5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
 6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
 8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.7 HIGH-BAY OCCUPANCY SENSORS

- 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. Hubbell Building Automation, Inc.

- C. General Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
 3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
 4. Operating Ambient Conditions: 32 to 149 deg F (0 to 65 deg C).
 5. Mounting: Threaded pipe.
 6. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 7. Detector Technology: PIR.
 8. Power and dimming control from the lighting fixture ballast that has been modified to include the dimming capacitor and MyzerPORT option.
- D. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet (3.7 to 15.2 m).
- E. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.8 EXTREME-TEMPERATURE OCCUPANCY SENSORS

- 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. Cooper Industries, Inc.
 2. Sensor Switch, Inc.
- C. Description: Ceiling-mounted, solid-state, extreme-temperature occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended application in damp locations.
 2. Operation: Turn lights on when the coverage area is occupied and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 3. Operating Ambient Conditions: From minus 40 to plus 125 deg F (minus 40 to plus 52 deg C).
 4. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
 5. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. The sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 6. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind cover.
 7. Bypass Switch: Override the "on" function in case of sensor failure.

8. Automatic Light-Level Sensor: Adjustable from 2 to 10 fc (21.5 to 108 lux); keep lighting off when selected lighting level is present.
- D. Detector Technology: PIR. Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
 2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1500 sq. ft. (139 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
 3. Detection Coverage (High Bay): Detect occupancy within 25 feet (7.6 m) when mounted on a 25-foot- (7.6-m-) high ceiling.

2.9 OUTDOOR MOTION SENSORS

- 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. Bryant Electric; a Hubbell company.
 2. Cooper Industries, Inc.
 3. Hubbell Building Automation, Inc.
 4. Leviton Mfg. Company Inc.
 5. Lithonia Lighting; Acuity Lighting Group, Inc.
 6. NSi Industries LLC; TORK Products.
 7. RAB Lighting.
 8. Sensor Switch, Inc.
 9. Watt Stopper.
- C. General Requirements for Sensors: Solid-state outdoor motion sensors.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application].
 2. [PIR] [Dual technology (PIR and infrared)] type, weatherproof. Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm). Comply with UL 773A.
 3. Switch Rating:
 - a. Lighting-Fixture-Mounted Sensor: [1000-W incandescent, 500-VA fluorescent].
 - b. Separately Mounted Sensor: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. The sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
 4. Switch Type: [SP.] [SP, dual circuit.] [SP, manual "on," automatic "off."] [SP, field selectable automatic "on," or manual "on" automatic "off."][With bypass switch to override the "on" function in case of sensor failure.]
 5. Voltage: [Match the circuit voltage] [120-V] [277-V] [Dual voltage, 120- and 277-V] type.
 6. Detector Coverage:
 - a. Standard Range: 210-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).
 - b. Long Range: 180-degree field of view and 110-foot (34-m) detection range.
 7. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lux). The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.

8. Concealed, field-adjustable, "off" time-delay selector of up to 30 minutes.
9. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
10. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
11. Operating Ambient Conditions: Suitable for operation in ambient temperatures ranging from minus 40 to plus 130 deg F (minus 40 to plus 54 deg C), rated as "raintight" according to UL 773A.

2.10 LIGHTING CONTACTORS

- 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. Allen-Bradley/Rockwell Automation.
 2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
 3. Eaton Corporation.
 4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control.
 5. Square D; a brand of Schneider Electric.
- C. Description: Electrically operated and mechanically held, combination-type lighting contactors with fusible switch, complying with NEMA ICS 2 and UL 508.
 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 3. Enclosure: Comply with NEMA 250.
 4. Provide control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- D. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
 1. Monitoring: On-off status.
 2. Control: On-off operation.

2.11 EMERGENCY SHUNT RELAY

- 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. Lighting Control and Design; Acuity Lighting Group, Inc.
 2. Watt Stopper.
 3. Lutron
- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 1. Lighting Control and Design; Acuity Lighting Group, Inc.
 2. Watt Stopper.
 3. Lutron

- C. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

- 1. Coil Rating: 120V OR 277V.

2.12 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "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 Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than [No. 18] AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

- A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch (13 mm).
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify controlled circuits in lighting contactors.
 - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections 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 safety. Replace damaged and malfunctioning controls and equipment.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to 2 visits to Project during other-than-normal occupancy hours for this purpose.
 - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.7 DEMONSTRATION

- A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.13 "Addressable-Fixture Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.

1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

- C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolts inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Electrical Inc.; Cutler-Hammer Products.
 - 2. General Electric Company.
 - 3. Siemens Energy & Automation, Inc.
 - 4. Sola/Hevi-Duty.
 - 5. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Core: One leg per phase.
- C. Enclosure: Ventilated, NEMA 250, Type 1.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- D. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finishing Color: Gray.
- E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- F. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- G. 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.
- H. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic, or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are needed to maintain working clearances required by NFPA 70 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 the location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 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. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions.

3.3 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."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- C. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- E. Remove and replace units that do not pass tests or inspections, and retest as specified above.
- F. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.

3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- G. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- 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.

END OF SECTION

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SECTION 26 24 13

SWITCHBOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes service and distribution switchboards rated 600 V and less.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RMS: Root mean square.

1.4 SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 3R.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of switchboards and overcurrent protective devices.
 - d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - e. Utility company's metering provisions with indication of approval by utility company.
 - f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

- E. 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 curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- C. Source Limitations: Obtain switchboards through one source from a single manufacturer.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- F. Comply with NEMA PB 2, "Dead front Distribution Switchboards."
- G. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in sections or lengths that can be moved past obstructions in delivery path.
- B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250 W per section) to prevent condensation.
- D. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.7 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide a pathway for moving switchboards into place.
- B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 125 deg F.
 - 2. Altitude: Not exceeding 2000 feet
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 2000 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolts inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MANUFACTURED UNITS

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Protection Div.
 - 3. Square D.
- B. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.
- C. Nominal System Voltage: 480Y/277 V.
- D. Main-Bus Continuous: 1200 A.
- E. Enclosure: Steel, NEMA 250, Type 3R.
- F. Enclosure Finish for Outdoor Units: Factory-applied finish in manufacturer's standard color, undersurfaces treated with corrosion-resistant undercoating.

- G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- H. Barriers: Between adjacent switchboard sections.
- I. Insulation and isolation for main and vertical buses of feeder sections.
- J. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If a separate vertical section is required for utility metering, match and align with basic switchboard.
- K. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- L. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- M. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- N. Pull Box on Top of Switchboard:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 2. Set back from front to clear circuit-breaker removal mechanism.
 - 3. Removable covers shall form top, front, and sides. Top covers at rear shall be easily removable for drilling and cutting.
 - 4. The bottom shall be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 - 5. Cable support shall be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- O. Buses and Connections: Three phase, four wire, unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
 - a. If the bus is copper, use copper for feeder circuit-breaker line connections.
 - 2. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full ampere rating of circuit-breaker position.
 - 3. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors.
 - 4. Contact Surfaces of Buses: Silver plated.
 - 5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 - 7. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables.
- P. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- Q. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating: 105 deg C.

2.3 TRANSIENT VOLTAGE SUPPRESSION DEVICES

- A. IEEE C62.41, integrally mounted, plug-in-style, solid-state, parallel-connected, sinewave tracking suppression and filtering modules.
- B. Minimum single-impulse current rating shall be as follows:
 - 1. Line to Neutral: 200,000 A.
 - 2. Line to Ground: 200,000 A
 - 3. Neutral to Ground: 100000 A.
- C. Protection modes shall be as follows:
 - 1. Line is too neutral.
 - 2. Line to ground.
 - 3. Neutral to ground.
- D. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz.
- E. Maximum Category C combination wave clamping voltage shall not exceed 1000 V, line to neutral and line to ground on 277/480 V systems.
- F. Maximum UL 1449 clamping levels shall not exceed 800 V, line to neutral and line to ground on 277/480 V systems.
- G. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.
- H. Accessories:
 - 1. Form-C contacts, one normally open and one normally closed, for remote monitoring of system operation. Contacts to reverse position on failure of any surge diversion module.
 - 2. Audible alarm activated on failure of any surge diversion module.
 - 3. Six-digit transient-counter set to total transient surges that deviate from the sine-wave envelope by more than 125 V.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and 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.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- D. Fuses are specified in Division 26 Section "Fuses."

2.5 INSTRUMENTATION

- A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with 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. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
 2. Mounting: Display and control unit flush or semi flush mounted in instrument compartment door.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.
- B. Install and anchor switchboards level on concrete bases, 4-inch (100-mm) nominal thickness. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.
1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 2. For switchboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 4. Install anchor bolts to elevations required for proper attachment to switchboards.

- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. 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.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- C. Perform the following field tests and inspections and prepare test reports:
 - 1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace them with new units and retest.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of switchboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match the original finish.

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SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Load centers.
 - 4. Electronic-grade panelboards.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detailed bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for series rating of installed devices.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include wiring diagrams for power, signal, and control wiring.
 - 8. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Panelboard Schedules: For installation on panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
 - 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Comply with NEMA PB 1.
- F. Comply with NFPA 70.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
 - b. Altitude: Not exceeding 6600 feet (2000 m).
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet (2000 m).
- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than two days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.
 - 3. Comply with NFPA 70E.

1.11 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolts inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.12 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R
 - c. Kitchen / 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 Noncorrosive Liquids: NEMA 250, Type 5.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 - 6. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel. Same finish as panels and trim.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
 - 7. Directory Card: Inside panelboard door, mounted in transparent card holder.
- C. Incoming Mains Location: Top and bottom.
- D. 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.
 - 5. Split Bus: Vertical buses divided into individual vertical sections.

- E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Compression type.
 3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Sub feed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed, and labeled for series-connected short-circuit rating by an NRTL.
- I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards 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."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 DISTRIBUTION PANELBOARDS

- 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. 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.
- C. Panelboards: NEMA PB 1, power and feeder distribution type.
- D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

- E. Mains: Circuit breaker, Fused switch, and Lugs only.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.
- G. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- H. Branch Overcurrent Protective Devices: Fused switches.
- I. Contractors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. External Control-Power Source: 120-V branch circuit, 24-V control circuit.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- 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. 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.
- C. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- D. Mains: Circuit breaker or lugs only.
- E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- F. Contractors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
 - 2. External Control-Power Source: 120-V branch circuit, 24-V control.
- G. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- H. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

2.5 LOAD CENTERS

- 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. 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.
- C. Load Centers: Comply with UL 67.
- D. Mains: Circuit breaker or Lugs only.
- E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- F. Conductor Connectors: Mechanical type for main, neutral, and ground lugs and buses.

2.6 ELECTRONIC-GRADE PANELBOARDS

- 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. Current Technology; a subsidiary of Danahar Corporation.
 2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
 3. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
 4. Liebert Corporation.
 5. Siemens Energy & Automation, Inc.
 6. Square D; a brand of Schneider Electric.
- C. Panelboards: NEMA PB 1; with factory installed, integral TVSS; labeled by an NRTL for compliance with UL 67 after installing TVSS.
- D. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
- E. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- F. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.
- G. Buses:
1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
 2. Copper equipment and isolated ground buses.

2.7 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- 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. 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.

- C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. 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. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression or Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Communication Capability: Circuit-breaker-mounted or Universal-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
 - f. Shunt Trip: 120 or 24 -V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - h. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contact's mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - i. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - j. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - k. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - l. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - m. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in [on] [off] [on or off] position.
 - n. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

- D. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
 - 1. Fuses, and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
 - 2. Fused Switch Features and Accessories: Standard ampere ratings and number of poles.
 - 3. Auxiliary Contacts: One normally open and normally closed contact(s) that operate with switch handle operation.

2.8 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 - 2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to panelboards.
 - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- D. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- E. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

- F. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- G. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- H. Install filler plates in unused spaces.
- I. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.
- J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- K. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "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 directories; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "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 Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace them with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in an Overcurrent Protective Device Coordination Study.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Twist-locking receptacles.
 - 3. Wall-box motion sensors.
 - 4. Snap switches.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
 2. Leviton Mfg. Company Inc. (Leviton).
 3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; 5362 (duplex).
 - b. Leviton; 5362 (duplex).
 - c. Pass & Seymour; 5362 (duplex).

2.3 GFCI RECEPTACLES

- A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; HGF8300.
 - b. Leviton; 6898-HG.
 - c. Pass & Seymour; 2091-SHG.

2.4 SNAP SWITCHES

- A. Comply with NEMA WD 1 and UL 20.
- B. Switches, 120/277 V, 20 A:
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
 - b. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
 - c. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.5 WALL-BOX SENSORS

A. Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; WS1277.
 - b. Leviton; ODS 10-ID.
 - c. Pass & Seymour; WS3000.
 - d. Watt Stopper (The); WS-200.
3. Description: Passive-infrared type, 120/277 V, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 sq. ft. (84 sq. m).

B. Long-Range Wall-Switch Sensors:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Hubbell; ATD1600WRP.
 - b. Leviton; ODW12-MRW.
 - c. Watt Stopper (The); DT-200.
3. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft. (111 sq. m).

2.6 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic,
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant thermoplastic with lockable cover.

2.7 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: White, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.
- B. Coordination with Other Trades:
 - 1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without 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. Pig tailing existing conductors is permitted provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
 - 1. Install ground pin of vertically mounted receptacles up and on horizontally mounted receptacles to the right.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."

- 1. Receptacles: Identify panelboard and circuit number from which served.

3.3 FIELD QUALITY CONTROL

- A. Tests for Convenience Receptacles:

- 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.

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SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Cartridge fuses rated 600 V and less for use in switches.

1.3 SUBMITTALS

- A. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data.
 - 4. Fuse size for elevator feeders and elevator disconnect switches.
- B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - 1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - a. Let-through current curves for fuses with current-limiting characteristics.
 - b. Time-current curves, coordination charts and tables, and related data.
 - c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fuses from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NEMA FU 1.

D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussman, Inc.
2. Ferraz Shawmut, Inc.
3. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Feeders: Class RK1, time delay.
- B. Motor Branch Circuits: Class RK1 time delay.
- C. Other Branch Circuits: Class RK1, time delay.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on the inside door of each fused switch.

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SECTION 26 51 00

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

- 1. Interior lighting fixtures, lamps, and ballasts.
- 2. Emergency lighting units.
- 3. Lighting fixture supports.

- B. Related Sections include the following:

- 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. BF: Ballast factor.
- B. CRI: Color-rendering index.
- C. CU: Coefficient of utilization.
- D. HID: High-intensity discharge.
- E. LER: Luminaire efficacy rating.
- F. Luminaire: Complete lighting fixture, including ballast housing if provided.
- G. RCR: Room cavity ratio.

1.4 SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Ballast.
 - 4. Energy-efficiency data.
 - 5. Life, output, and energy-efficiency data for lamps.

6. Photometric data, in IESNA format, based on laboratory tests of each lighting fixture type, outfitted with lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
 - a. For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by the manufacturer.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
 1. Wiring Diagrams: Power wiring.
- C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 1. Lighting fixtures.
 2. Suspended ceiling components.
 3. Structural members to which suspension systems for lighting fixtures will be attached.
 4. Other items in finished ceiling including the following:
 - a. Air outlets and inlets.
 - b. Speakers.
 - c. Sprinklers.
 - d. Smoke and fire detectors.
 - e. Occupancy sensors.
 - f. Access panels.
- D. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.

1.6 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for the first year, and prorated warranty for the remaining nine years.
 - 2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for the first year, and prorated warranty for the remaining six years.
- B. Special Warranty for Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Electronic Ballasts: Five years from date of Substantial Completion.
 - 2. Warranty Period for Electromagnetic Ballasts: Three years from date of Substantial Completion.
- C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
 - 1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Interior Lighting Fixture Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to, manufacturers specified.

2.2 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- C. HID Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5B.
- D. Metal Parts: Free of burrs and sharp corners and edges.

- E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
- F. 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.
- G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- H. Plastic Diffusers, Covers, and Globes:
 - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless different thickness is indicated.
 - b. UV stabilized.
 - 2. Glass: Annealed crystal glass, unless otherwise indicated.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

- A. Electronic Ballasts: Comply with ANSI C82.11; instant-start type, unless otherwise indicated, and designed for type and quantity of lamps served. Ballasts shall be designed for full light output unless dimmer or bi-level control is indicated.
 - 1. Sound Rating: A.
 - 2. Total Harmonic Distortion Rating: Less than 10 percent.
 - 3. Transient Voltage Protection: IEEE C62.41, Category A or better.
 - 4. Operating Frequency: 20 kHz or higher.
 - 5. Lamp Current Crest Factor: 1.7 or less.
 - 6. BF: 0.85 or higher.
 - 7. Power Factor: 0.98 or higher.
 - 8. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C 82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.
- B. Ballasts for Bi-Level Controlled Lighting Fixtures: Electronic type.
 - 1. Operating Modes: Ballast circuit and leads provide for remote control of the light output of the associated lamp between high- and low-level and off.
 - a. High-Level Operation: 100 percent of rated lamp lumens.
 - b. Low-Level Operation: 30 percent of rated lamp lumens.
 - 2. Ballast shall provide equal current to each lamp in each operating mode.
 - 3. Compatibility: Certified by manufacturer for use with specific bi-level control system and lamp type indicated.

2.4 EMERGENCY FLUORESCENT POWER UNIT

- A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
 - 1. Emergency Connection: Operate 2 fluorescent lamp(s) continuously at an output of 675 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
 - 2. Night-Light Connection: Operate one fluorescent lamp continuously.
 - 3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 4. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 - 6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and flashing red LED.

2.5 FLUORESCENT LAMPS

- A. Low-Mercury Lamps: Comply with EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.
- B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches, 3100 initial lumens (minimum), CRI 85 (minimum), color temperature 3500 and average rated life 20,000 hours, unless otherwise indicated.

2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports, and nonmetallic channel and angle supports.
- B. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- C. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) 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 (20-mm) 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 broken strength of the weight of fixture at a safety factor of 3.

C. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to the lighting system, retest to demonstrate compliance with standards.

END OF SECTION

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Luminaire-mounted photoelectric relays.
 - 3. Poles and accessories.
- B. Related Sections include the following:
 - 1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

- A. CRI: Color-rendering index.
- B. HID: High-intensity discharge.
- C. Luminaire: Complete lighting fixture, including ballast housing if provided.
- D. Pole: Luminaire support structure, including tower used for large area illumination.
- E. Standard: Same definition as "Pole" above.

1.4 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 - 2. Details of attaching luminaires and accessories.
 - 3. Details of installation and construction.
 - 4. Luminaire materials.
 - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by the manufacturer.

6. Photoelectric relays.
7. Ballasts, including energy-efficiency data.
8. Lamps, including life, output, and energy-efficiency data.
9. Materials, dimensions, and finishes of poles.
10. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

B. Shop Drawings:

1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

C. Samples for Verification: For products designated for sample submission in Exterior Lighting Device Schedule. Each sample shall include lamps and ballasts.

D. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

E. Qualification Data: For agencies providing photometric data for lighting fixtures.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.

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 IEEE C2, "National Electrical Safety Code."

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.7 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. Manufacturers 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.
 4. Warranty Period for Lamps: Replace lamps and fuses that fail within 12 months from date of Substantial Completion.
 5. 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

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
- B. In Exterior Lighting Device Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include but are not limited to, manufacturers specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 3. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 LUMINAIRES, GENERAL REQUIREMENTS

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: Black.

2.3 FLUORESCENT BALLASTS AND LAMPS

- A. Low-Temperature Ballast Capability: Rated by its manufacturer for reliable starting and operation of indicated lamp(s) at temperatures **0 deg F** and higher.
- B. Ballast Characteristics:
 - 1. Power Factor: 90 percent, minimum.
 - 2. Sound Rating: A.
 - 3. Total Harmonic Distortion Rating: Less than 10 percent.
 - 4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
 - 5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
 - 6. Transient-Voltage Protection: Comply with IEEE C62.41 Category A or better.
- C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures 0 deg F and higher.

- D. Fluorescent Lamps: Low-mercury type. Comply with the EPA's toxicity characteristic leaching procedure test; shall yield less than 0.2 mg of mercury per liter when tested according to NEMA LL 1.

2.4 BALLASTS FOR HID LAMPS

- A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features, unless otherwise indicated:
 - 1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
 - 2. Minimum Starting Temperature: Minus 22 deg F.
 - 3. Normal Ambient Operating Temperature: 122 deg F.
 - 4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.5 HID LAMPS

- A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.
- B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000K.

2.6 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4.
 - 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 Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.
 - 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 stainless-steel items are indicated.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

2.7 STEEL POLES

- A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig ; 1-piece construction up to 30 feet in height with access handhole in pole wall.
 - 1. Shape: Round, tapered.
 - 2. Mounting Provisions: Butt flange for bolted mounting on foundation.
- B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.

- C. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.
- D. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

2.8 POLE ACCESSORIES

- A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicate structural supports.
 - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

3.2 POLE INSTALLATION

- A. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

3.3 INSTALLATION OF INDIVIDUAL GROUND-MOUNTING LUMINAIRES

- A. Install on concrete base with top 4 inches (100 mm) above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.4 CORROSION PREVENTION

- A. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 GROUNDING

- A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - 1. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.6 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.

END OF SECTION

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SECTION 28 31 00

FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
- B. The system shall be able to support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center when necessary. All Fire Command Centers shall be individually capable of assuming Audio Command functions such as Emergency Paging, audio zone control functions, and Firefighter's Telephone communication functions.
- C. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.
- D. The fire alarm system shall be manufactured by an ISO 9001:2008 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994
- E. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof). It's acceptable for peripheral devices to be manufactured outside of the U.S. by a division of the U.S. based parent company.
Preferred Manufacturers are as follows:
 - 1. Siemens
 - 2. Notifier
 - 3. Simplex (Johnson Controls)
 - 4. Honeywell
- F. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.
- G. The installation company shall employ NICET (minimum Level IV Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the system's integrity.

1.2 SUMMARY

- A. Section Includes:
 - 1. Addressable fire-alarm system.
 - 2. Fire-alarm control unit (FACU).
 - 3. Manual fire-alarm boxes.
 - 4. System smoke detectors.
 - 5. Duct smoke detectors.
 - 6. Projected beam smoke detectors.
 - 7. Carbon monoxide detectors.
 - 8. Heat detectors.
 - 9. Fire-alarm notification appliances.
 - 10. Fire-alarm graphic annunciators.

11. Fire-alarm remote annunciators.
12. Fire-alarm addressable interface devices.
13. Digital alarm communicator transmitters (DACTs).

B. Related Requirements:

1. Section 087100 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" or Section 260523 "Control Voltage Electrical Power Cables" for cables and conductors for fire-alarm systems.

1.3 SCOPE

A. A new intelligent reporting, microprocessor-controlled fire detection system shall be installed in accordance with the project specifications and drawings.

B. Basic Performance:

1. Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.
2. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.
3. On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
4. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
5. Speaker circuits may be controlled by NAC outputs built into the amplifiers, which shall function as addressable points on the Digital Audio Loop.
6. NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone, whichever is greater.
7. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.
8. NAC speaker circuits and control equipment shall be arranged such that loss of anyone (1) speaker circuit will not cause the loss of any other speaker circuit in the system. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions. Speaker circuits shall be arranged such that there is a minimum of one speaker circuit per smoke zone. Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.
9. Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Digital amplifiers shall provide built-in speaker circuits, field configurable as four Class B (Style Y), or two Class A (Style Z) circuits.
10. Digital amplifiers shall be capable of storing up to two minutes of digitally recorded audio messages and tones. The digital amplifiers shall also be capable of supervising the connection to the associated digital message generator, and upon loss of that connection shall be capable of one of the following system responses:
 - a. The digital amplifier shall automatically broadcast the stored audio message.
 - b. The digital amplifier shall switch to a mode where a local bus input on the digital amplifier will accept an input to initiate a broadcast of the stored message. This bus input shall be connected to a NAC on a local FACP for the purpose of providing an alternate means of initiating an emergency message during a communication fault condition.
 - c. Speaker circuits shall be either 25 VRMS or 70VRMS. Speaker circuits shall have 20% space capacity for future expansion or increased power output requirements.

- d. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Audio Command Center and up to seven (7) remote Fire Fighter's Telephone locations simultaneously on a telephone riser.
- e. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.
- f. The digital audio message generator shall be of reliable, non-moving parts, and support the digital storage of up to 32 minutes of tones and emergency messages, shall support programming options to string audio segments together to create up to 1000 messages, or to loop messages and parts of messages to repeat for pre-determined cycles or indefinitely.

1.4 SUBMITTALS

A. General:

- 1. The contractor shall be responsible for preparing and providing shop drawings for review and approval by both the Electrical Engineer and local Fire Marshal.
- 2. All references to manufacturer's model numbers and other pertinent information herein are intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
- 3. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. Shop Drawings:

- 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
- 2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
- 3. Show annunciator layout, configurations, and terminations.

C. Manuals:

- 1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
- 2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
- 3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

D. Software Modifications

- 1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
- 2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

E. Certifications:

1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

1.5 WARRANTY

- A. All work performed, and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least two (2) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one-year period shall be included in the submittal bid.

1.6 POST CONTRACT MAINTENANCE:

- A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of Two (2) years after expiration of the guaranty.
- B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs may not be accepted. Rates and costs shall be valid for the period of two (2) years after expiration of the guaranty.
- C. Maintenance and testing shall be on a semiannual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:
 1. Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.
 2. Each circuit in the fire alarm system shall be tested semiannually.
 3. Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

1.7 APPLICABLE STANDARDS AND SPECIFICATIONS

- A. The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.
- B. National Fire Protection Association (NFPA) - USA:

No. 12	Extinguishing Systems (low and high)
No. 12A	Halon 1301 Extinguishing Systems
No. 13	Sprinkler Systems
No. 15	Water Spray Systems
No. 16	Foam / Water Deluge and Spray Systems
No. 17	Dry Chemical Extinguishing Systems
No. 17A	Wet Chemical Extinguishing Systems
No. 2001	Clean Agent Extinguishing Systems
No. 70	National Electric Code
No. 90A	Air Conditioning Systems
No. 92A	Smoke Control Systems
No. 92B	Smoke Management Systems in Malls, Atria, Large Areas
No. 72	National Fire Alarm Code

No. 101	Life Safety Code
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C. Underwriters Laboratories Inc. (UL) - USA:

No. 268	Smoke Detectors for Fire Protective Signaling Systems
No. 864	Control Units for Fire Protective Signaling Systems
No. 2572	Mass Notification Systems
No. 217	Smoke Detectors, Single and Multiple Station
No. 228	Door Closers - Holders for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective Signaling Systems
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 1481	Power Supplies for Fire Protective Signaling Systems
No. 346	Waterflow Indicators for Fire Protective Signaling Systems
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971	Visual Notification Appliances
No. 2017	Standard for General-Purpose Signaling Devices and Systems
No.60950	Safety of Information Technology Equipment

D. Local and State Building Codes.

E. All requirements of the Authority Having Jurisdiction (AHJ).

1.8 APPROVALS

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL	Underwriters Laboratories, Inc
ULC	Underwriters Laboratories Canada
FM	Factory Mutual
FM 6320	Factory Mutual Gas Detection System
NYFD	New York Fire Department
CSFM	California State Fire Marshal

B. The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of low-pressure CO2.

C. The system shall be certified for seismic applications in accordance with the International Building Code (IBC).

D. The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the FMM-4-20 monitor module and industry standard 4-20 mA gas detectors.

PART 2 PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL

- A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment, and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.
- B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.2 CONDUIT AND WIRE

A. Conduit:

- 1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
- 2. Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross-sectional area where three or more cables are contained within a single conduit.
- 3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760.
- 4. Wiring for 24-volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
- 5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
- 6. Conduit shall be 3/4-inch (19.1 mm) minimum.

B. Wire:

- 1. All fire alarm system wiring shall be new.
- 2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits, Signaling Line Circuits, and Notification Appliance Circuits.
- 3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
- 4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
- 5. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
- 6. All field wiring shall be electrically supervised for open circuit and ground fault.

7. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems that do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.
- C. Terminal Boxes, Junction Boxes and Cabinets:
 1. All boxes and cabinets shall be UL listed for their use and purpose.
- D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
- E. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold-water pipe or grounding rod.

2.3 MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE

- A. Main FACP or network node and shall contain a microprocessor based Central Processing Unit (CPU) and power supply in an economical space saving single board design. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system-controlled devices.
- B. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:
 1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
 2. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
 3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall be fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

2.4 SYSTEM CAPACITY AND GENERAL OPERATION

- A. The FACP shall be capable of communicating over a Local Area Network (LAN) or Wide Area Network (WAN) utilizing a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mb and support up to 200 panels / nodes per network.
- B. The control panel shall be capable of expansion of up to 10 SLC loops. Each module shall support up to 318 analog/addressable devices for a maximum system capacity of 3180 points.
- C. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640-character liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company.
- D. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

E. The FACP shall be able to provide the following software and hardware features:

1. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.
2. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
3. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
4. Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on Alarm level.
5. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
6. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
7. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the sensitivity testing requirements of NFPA 72.
8. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
9. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop. A single change to one CPU database shall not require a database download to other CPUs.
10. History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000-event history file.
11. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.
12. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
13. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
14. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions
15. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.
16. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

17. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
18. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.
19. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.
20. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen.
21. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector with up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result of all cooperating detectors chamber readings.
22. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.
23. NON-FIRE Alarm Module Reporting: A point with a type of ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation, nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.
24. Mass Notification Override: The system shall be UL 2572 listed for Mass Notification and shall be capable, based on the Risk Analysis, of being programmed so that Mass Notification/Emergency Communications events take precedence over fire alarm events.
25. Security Monitor Points: The system shall provide means to monitor any point as a type of security.
26. One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pulling station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.
27. Control By Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.
28. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

29. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.
30. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.
31. 100 trouble equations per device: The system shall provide support for up to 100 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.
32. Control-By-Time: A time-based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24-hour time schedule on any day of the week or year.
33. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.
34. Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, trouble shall be generated to the panel.

F. Network Communication

1. The FACP shall be capable of communicating over a Local Area Network (LAN) or Wide Area Network (WAN) utilizing a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mb and support up to 200 panels/nodes per network.

G. Central Processing Unit

1. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory and shall not be lost with system primary and secondary power failure.
2. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
3. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
4. The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
5. The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.
6. The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.

H. Display

1. The system display shall provide a 640-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide eleven Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, CONTROLS ACTIVE, and CPU FAILURE.
2. The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

I. Loop (Signaling Line Circuit) Control Module:

1. The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Ionization, Photoelectric, or Thermal) and 159 monitor or control modules.
2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
3. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
4. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

J. Addressable Charger Power Supply

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24 VDC power.
2. The addressable power supply for the fire detection system shall provide up to a minimum of 6.0 amps of 24-volt DC regulated power for Notification Appliance Circuit (NAC) power or 10.0 amps of 24-volt DC general power. The power supply shall have an additional 0.5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 12 - 200-amp hour batteries.
3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as Class "A" or Class "B" circuits. All circuits shall be power limited per UL 864 requirements.
4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.
5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.
6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.
7. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a troubled condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.

8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of zero, two, eight or sixteen hours shall be programmable.
9. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be programmable.
10. The addressable power supply mounts in either the FACP backbox or its own dedicated surface mounted backbox with cover.
11. Each of the power supply's four output circuits shall be programmed- for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
12. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of an end-of-line resistor. When the power supply's output circuit is selected as General 24 VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
13. When selected for Notification Appliance Circuits, the output circuits shall be individually programmable for Steady, March Time, Dual Stage or Temporal.
14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
16. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

K. Remote Transmissions:

1. Provide local energy or polarity reversal or trip circuits as required.
2. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.
3. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.
4. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation, and other required features.

L. Field Programming

1. The system shall be programmable, configurable, and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
2. It shall be possible to program through the standard FACP keyboard all system functions.
3. All field defined programs shall be stored in non-volatile memory.
4. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one-minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.
5. The system programming shall be "backed" up via an upload/download program and stored on compatible removable media. A system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

6. The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned into the engineer(s) on record.

M. Specific System Operations

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 0 to 60 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

N. System Point Operations:

1. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
2. System output points shall be capable of being turned on or off by the system keypad or the video terminal.
3. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
 - a. Device Status.
 - b. Device Type.
 - c. Custom Device Label.
 - d. Software Zone Label.
 - e. Device Zone Assignments.
 - f. Analog Detector Sensitivity.
 - g. All Program Parameters.
4. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.
5. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.
6. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
7. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
8. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personnel when a detector is at 80% of its alarm threshold in a 60 second period.

2.5 GATEWAY & WEBSERVER OPTIONS

- A. Common Alerting Protocol (CAP) Gateway: The system shall support an optional CAP Gateway (Common Alerting Protocol). The CAP Gateway translates fire system messages to industry standard CAP messages for integration with CAP-compliant clients. A CAP gateway shall be available from the fire alarm control panel manufacturer.
- B. LEDSIGN Gateway: The system shall support an optional and proprietary LEDSIGN Gateway to interface to LED signs that will automatically display emergency messages. The signs shall be capable of storing up to 100 messages that can be activated via system programming with the ability to be manually overridden. The Sign Gateway shall support up to 10 independent signs, each sign capable of playing an independent message. Multiple LEDSIGN Gateways can be used in network applications. An LEDSIGN gateway shall be available from the fire alarm control panel manufacturer.
- C. BACnet Interface Gateway: The system shall be capable of being interfaced with BACnet compliant clients. A BACnet interface supporting BACnet/IP communication shall be available from the fire alarm control panel manufacturer.
- D. MODbus Interface Gateway: The system shall be capable of being interfaced with MODbus compliant clients. A MODbus interface supporting MODbus/TCP communication shall be available from the fire alarm control panel manufacturer.
- E. Gateway: The system shall support an IP based gateway to enable the panel or local node to be connected to workstation via the Internet or Intranet. This gateway shall also support the ability to integrate the system to an interactive firefighter's display. The Gateway shall be available from the fire alarm control manufacturer.
- F. Webserver: The system shall support a webserver allowing remote connection via the Internet or Intranet. Authorized users will have the ability to view panel/network history, event status and device properties. The webserver shall also support sending event information via email or text to up to 50 registered users, the webserver shall be available from the fire alarm control panel manufacturer.
- G. Web Portal Interface: The system shall be capable of being interfaced with a web portal to integrate with Inspection and Service Manager utilities. The web portal and inspection and service manager utilities shall be available from the fire alarm control panel manufacturer.

2.6 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

- A. Addressable Devices - General
 - 1. Addressable devices shall be used simple to install and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.
 - 2. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address to be programmed using a special tool or programming utility are not an allowable substitute.
 - 3. Detectors shall be intelligent (analog) and addressable and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.
 - 4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type of code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
12. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
13. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.

B. Addressable Manual Fire Alarm Box (manual station)

1. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type of reset.
3. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

C. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Notifier FSP-851.

D. Laser Photo Smoke Detector: The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.

1. The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.
2. The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.

3. The laser detector shall not require expensive conduit, special fittings or PVC pipe.
 4. The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
 5. The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
 6. The laser photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.
- E. Intelligent Ionization Smoke Detector: The intelligent ionization smoke detector shall use the dual-chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analog level of products of combustion.
- F. Intelligent Multi Criteria Detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
1. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
 2. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.
- G. Intelligent Thermal Detectors: The intelligent thermal detectors shall be series addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. A high heat thermal detector rated at 190 degrees Fahrenheit shall also be available. The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.
- H. Intelligent Duct Smoke Detector: The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action is taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. The Intelligent Duct Smoke Detector shall support the installation of addressable Photoelectric detector capable of being tested remotely.
- I. Intelligent Multi-Criteria Intelligent Detector
1. Intelligent multi-criteria fire detector shall be an addressable intelligent multi-criteria smoke detector. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical carbon monoxide (CO) sensor, a daylight-filtered infrared sensor and solid-state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.

2. The intelligent multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in an effort to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The product design shall be capable of selecting the appropriate sensitivity levels based on the environment type chosen by user in which it is installed (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes.
3. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20% of the drift range is remaining, when 100% of drift range is used, and when there is a chamber fault to show unit requires maintenance.
4. The detector shall indicate CO trouble conditions including 6 months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self-test failure, IR self-test failure, and freeze warning.
5. The detectors shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detectors shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one-off at least 99 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.
6. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There are three test methods: functional magnet, smoke entry aerosol, or direct heat method.
7. The detectors shall provide two LEDs to provide 360° visibility. The LEDs are placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED, sounder base, and / or relay base (optional accessories). The external remote alarm can be interconnected to other sounder or relay bases for activating all devices in a space via a single alarming unit.
8. Two LEDs on the sensor are controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, can cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.
9. The detectors shall be ceiling-mount and shall be plug-in mounted into a twist-lock base. These detectors shall be constructed of off-white UV resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base, and the head shall be a plug-in type. Mounting base shall be mounted on junction box which is at least 1.5 inches (3.81 cm) deep. Mounting base shall be available to mount to standard junction boxes. Suitable boxes include:
 - a. 4.0" (10.16 cm) square box with and without plaster ring.
 - b. 4.0" (10.16 cm) octagonal box.
 - c. 3.5" (8.89 cm) octagonal box.
 - d. Single-gang box.

10. Meets Agency Standards

- a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
- b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
- c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling

J. Advanced Multi-Criteria Intelligent Fire/CO Detector

1. Advanced Multi-Criteria Fire/CO detector shall be an addressable advanced multi-criteria smoke detector with a separate signal for carbon monoxide (CO) detection per UL 2075 standards.
2. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid-state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
3. The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.
4. The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.
5. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20 percent of the drift range is remaining, when 100 percent of drift range is used, and when there is a chamber fault to show the unit requires maintenance.
6. The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self-test failure, IR self-test failure, and freeze warning.
7. The detector shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detector shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one-off at least 159 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.
8. The detector shall provide a test means whereby it will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There shall be four test methods: functional magnet, smoke entry aerosol, carbon monoxide aerosol or direct heat method.
9. The detector shall provide two LEDs to provide 360° visibility. The LEDs shall be placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED. The detector must be capable of connecting to a sounder base that provides both temporal 3 and temporal 4 patterns for fire and CO alarm.
10. Two LEDs on the sensor shall be controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, shall cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.

11. The detector shall be plug-in mounted into a twist-lock base. The detector shall be constructed of off-white, UV-resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base, and the head shall be a plug-in type. The mounting base shall be mounted on a junction box that is at least 1.5 inches (3.81 cm) deep. The mounting base shall be available to mount to standard junction boxes. Suitable boxes include:
 - a. 4.0" (10.16 cm) square box with and without plaster ring.
 - b. 4.0" (10.16 cm) octagonal box.
 - c. 3.5" (8.89 cm) octagonal box.
 - d. Single-gang box.
 - e. Double-gang box
12. Meets Agency Standards
 - a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
 - b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
 - c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling
 - d. UL 2075 – Gas and Vapor Detector and Sensors – Systems Connected
- K. Intelligent Addressable Aspiration Detector: The intelligent aspiration detector shall be an addressable aspiration detector that communicates directly with the fire alarm control panel via the SLC communication protocol, no modules or high-level interfaces shall be required. The fire alarm control panel shall support up to thirty-one intelligent aspiration detectors per SLC loop. The aspiration detector shall have dual source (blue LED and infra-red laser) optical smoke detection for a wide range of fire detection with enhanced immunity to nuisance particulates. The FACP shall be capable of monitoring and annunciating up to five smoke event thresholds and eleven trouble conditions. Each event threshold shall be capable of being assigned a discrete type of ID at the FACP.
- L. Intelligent Addressable Reflected Beam Detector
 1. The intelligent single-ended reflected beam smoke detector shall connect with two wires to the fire alarm control panel signaling line circuit (SLC). The detectors shall consist of a transmitter/receiver unit and a reflector and shall send data to the panel representing the analog level of smoke density. The detector shall be capable of being tested remotely via a key switch and shall be equipped with an integral sensitivity test feature.
- M. Addressable Dry Contact Monitor Module
 1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs. The addressable monitor module shall be Class A or B.
 2. The IDC zone shall be suitable for Style D/Class A or Style B/Class B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
 3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4-inch (70 mm) x 1-1/4-inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.
 4. For multiple dry contact monitoring a module shall be available that provides 10 Style B or 5 Style D input circuits.

N. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional circuit of compatible Notification Appliances, 24 VDC powered, polarized audio/visual notification appliances.
2. The control module NAC may be wired for Style Z or Style Y (Class A/B) with a current rating of 2 Amps for Style Z and 3 Amps for Style Y.
3. Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised UL listed remote supply.
4. For multiple circuit control a module shall be available that provides 6 Style Y (Class B) or 3 Style Z (Class A) control circuits.

O. Addressable Releasing Control Module

1. An addressable Flash Scan releasing module shall be available to supervise and control compatible releasing agent solenoids.
2. The module shall operate on a redundant protocol for added protection.
3. The module shall be configurable for Style Z or Style Y (Class A/B) and support one 24 volt or two 12-volt solenoids.

P. Addressable 4-20 mA Module

1. Addressable 4-20 mA module shall be available to monitor industry-standard, linear-scale, 4-20 mA protocol sensors. The module converts the sensor output to communication protocol that can be interpreted by the FACP for monitoring and display.
2. The module shall support programming of up to five programmable event thresholds.
3. The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the FMM-4-20 monitor module and industry standard 4-20 mA gas detectors.

Q. Addressable Relay Module:

1. Addressable Relay Modules shall be available for HVAC control and other network building functions.
2. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.
3. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires.
4. For multiple relay control a module shall be available that provides 6 programmable Form-C relays.

R. Isolator Module: Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

1. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
2. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
3. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

S. Addressable Speakers

1. The speaker shall be listed to UL 1480 for Fire Protective Signaling Systems. It shall be a dual-voltage transformer speaker capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.
2. A universal mounting plate shall be used for mounting ceiling and wall speaker products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate.
3. Speakers shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker design shall isolate speaker components to reduce ground fault incidents.
4. The speaker shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction.
5. All notification appliances shall be backward compatible.

T. Addressable Speaker Strobes

1. The speaker strobe shall be listed at UL 1971 and UL 1480 and be approved for fire protective signaling systems. It shall be a dual-voltage transformer speaker strobe capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.
2. A universal mounting plate shall be used for mounting ceiling and wall speaker strobe products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate. Also the speaker strobes and the shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts (includes fire alarm panels with built in sync). When used the 12-volt rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 16.5 to 33 volts. If the notification appliances are not UL 9th edition listed with the corresponding panel or power supply being used, then refer to the compatibility listing of the panel to determine maximum devices on a circuit.
3. Speaker strobes shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. Speaker strobe design shall isolate speaker components to reduce ground fault incidents.
4. The speaker strobe shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction. The strobe shall consist of a xenon flash tube with associated lens/reflector system and operate on either 12V or 24V. The strobe shall also feature selectable candela output, providing options for 15 or 15/75 candela when operating on 12V and 15, 15/75, 30, 75, 110, or 115 when operating on 24V. The strobe shall comply with NFPA 72 and the Americans with Disabilities Act requirement for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range.
5. All notification appliances shall be backward compatible.

U. Addressable Horn Strobes

1. The Horn strobe shall be listed at UL 1971 and UL 464 and be approved for fire protective signaling systems. It shall be a dual-voltage transformer speaker strobe capable of operation at 25.0 or 70.7 nominal Vrms. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. It shall mount to a 4 x 4 x 2 1/8-inch back box.
2. A universal mounting plate shall be used for mounting ceiling and wall horn strobe products. The notification appliance circuit and amplifier wiring shall terminate at the universal mounting plate. Also the horn strobes shall be powered from a non-coded notification appliance circuit output and shall operate on a nominal 12 or 24 volts (includes fire alarm panels with built in sync). When used the 12-volt rated notification appliance circuit outputs shall operate between 8.5 and 17.5 volts; 24-volt rated notification appliance circuit outputs shall operate between 16.5 to 33 volts. If the notification appliances are not UL 9th edition listed with the corresponding panel or power supply being used, then refer to the compatibility listing of the panel to determine maximum devices on a circuit.
3. Horn strobes shall be plug-in and shall have the ability to check wiring continuity via a shorting spring on the universal mounting plate. The shorting spring shall also provide tamper resistance via an open circuit if the device is removed. horn strobe design shall isolate speaker components to reduce ground fault incidents.
4. The horn strobe shall have power taps (from ¼ watt to 2 watts) and voltage that are selected by rotary switches. All models shall have a maximum sound output of 86 dB at 10 feet and shall incorporate an open back construction. The strobe shall consist of a xenon flash tube with associated lens/reflector system and operate on either 12V or 24V. The strobe shall also feature selectable candela output, providing options for 15 or 15/75 candela when operating on 12V and 15, 15/75, 30, 75, 110, or 115 when operating on 24V. The strobe shall comply with NFPA 72 and the Americans with Disabilities Act requirement for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range.
5. All notification appliances shall be backward compatible.

2.7 BATTERIES

- A. The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.
- B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.
- C. If necessary to meet standby requirements, external battery and charger systems may be used.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown in the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports, and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

- C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- D. Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

3.2 TEST

- A. The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
 - 3. Verify activation of all waterflow switches.
 - 4. Open initiating device circuits and verify that the trouble signal actuates.
 - 5. Open and short signaling line circuits and verify that the trouble signal actuates.
 - 6. Open and short notification appliance circuits and verify that trouble signal actuates.
 - 7. Ground all circuits and verify response of trouble signals.
 - 8. Check presence and audibility of tone at all alarm notification devices.
 - 9. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
 - 10. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
 - 11. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.3 FINAL INSPECTION

- A. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

3.4 INSTRUCTION

- A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
- B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

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SECTION 31 20 00

EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Rough grading of subgrades for slabs-on-grade, walks, pavements, lawns, and landscape areas.
 - 2. Excavating and backfilling for buildings, site structures and screen walls.
 - 3. Preparation and compaction of building pad subbase.
 - 4. Subbase course for concrete walks and pavements.
 - 5. Base course for asphalt paving.
 - 6. Subsurface drainage backfill for walls and trenches.
 - 7. Excavating and backfilling trenches under building slab-on-grades.
 - 8. Excavating and backfilling trenches for buried water and electrical utilities.
 - 9. Excavating and backfilling trenches for buried drainage devices.
- B. Related Sections include the following:
 - 1. Section 03 30 00 for "Cast-in-Place Concrete" for granular course under building slabs.

1.02 RELATED DOCUMENTS

- A. Refer to soil and pavement recommendations of the Project Soils Report listed in Document 00880 "Soils Investigation Data".

1.03 DEFINITIONS

- A. Backfill: Soil materials used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Excavation: Removal of material encountered above subgrade elevations and subsequent reuse or disposal of excess materials removed.
 - 1. Additional Excavation: Excavation below subgrade elevations as directed by Engineer. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Bulk Excavation: Excavations more than 10 feet in width and pits more than 30 feet in either length or width.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Engineer.
- C. Fill: Soil materials used to raise existing grades. The materials used for fill shall contain no vegetation, ash, wood, man-made material, organic soils or any material which may decay or otherwise cause settlement.
- D. Import Select Fill: Suitable material shall be supplied with a plasticity index less than 20 from approved borrow sources. Materials imported to the project site shall be certified for compliance with the Soils Report recommendations.
- E. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

- F. Subbase Course: Layer placed between the subgrade and base course of asphalt paving, or layer placed between the subgrade and concrete pavement.
- G. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- H. Utilities: Includes underground pipes, conduits, ducts, and cables, as well as underground services under buildings.
- I. Engineer: Representative of the Geotechnical Testing Agency engaged by the Owner.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: For work performed within the public right-of-way, comply with, County standard specifications, City of Colorado Springs regulations, latest edition, if more stringent than herein specified.
- B. Geotechnical Testing Agency Qualifications: Owner will engage soil testing and inspection service for quality control testing during earthwork operations.
- C. Imported Fill: Provide an Environmental Report, in format acceptable to Owner, for all borrowed or imported soil material proposed to be used in the Work. Provide Report for Owner's review prior to delivery of fill materials to Project.

1.05 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Owner not less than ten days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
 - 4. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility company.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.
- C. Site Conditions: Data indicated on subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn there from by Contractor. Data are made available for convenience of Contractor.
 - 1. Additional test borings and other exploratory operations may be made by Contractor at no cost to Owner.
- D. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
 - 1. Barricade open excavations occurring as part of this work and post with warning lights.
 - 2. Operate warning lights as required by authorities having jurisdiction.
- E. Use of Explosives: The use of explosives is not permitted.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from on-site excavations.
- B. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SW, SP, and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches in any dimension, debris, waste, vegetation, ash, wood, organic soils or any man-made material and other deleterious matter, which may decay, shrink or otherwise cause settlement. Materials to be placed within 10' of the building areas shall be free from rock, stone or broken concrete.
- C. Import Select Fill: Suitable material shall be supplied with a plasticity index less than 20 from approved borrow sources. Materials imported to the project site shall be certified for compliance with the Soils Report recommendations.
- D. Backfill and Fill: Satisfactory soil materials.
- E. Sub-base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Subgrade: Existing soils which conform to the requirements of fill above on which select fill, or site fill is to be placed.
- G. Pavement Subgrade: Minimum 8 inch deep prepared subgrade of existing low-expansive on-site soils which conform to the requirements of site fills per Soils Report recommendations.
- H. On-site Sidewalk Base Course: Minimum 4 inch deep prepared subgrade of existing low -expansive granular on-site soils which conform to the requirements of site fills per Soils Report recommendations.
- I. Off-site Sidewalk Base Course: Undisturbed native soil or recompacted native soil.
- J. Pavement Base Course: See Drawings for limits of pavement types and thicknesses. Material corresponding to the soil report specifications in the following minimum depths:
 - 1. Service Duty Pavement Thickness Base Course Depth
 - a. Car parking 4" asphalt pavement 6 inches
 - b. Firelanes 4.5" asphalt pavement 6 inches
 - c. Ramps & Truck Court 6 " PCCP 12 inch compacted sub-grade

PART 3 - EXECUTION

3.01 GENERAL

- A. Refer to Soils Report recommendations for all earthwork.
- B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining and other hazards created by earthwork operations.
- C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing storm-water runoff to adjacent properties and walkways in accordance with local ordinances.

3.02 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.03 EXCAVATION, GENERAL

- A. Excavation: Excavations to subgrade elevations indicated is unclassified regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.
 1. Remove vegetation, debris, unsatisfactory soil materials and deleterious materials from ground surface prior to placement of fills. Plow-strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
 2. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
- B. Stability of Excavations: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
- C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

3.04 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 0.10 of a foot. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections. See Soils Report for footing elevation alternative options.
- B. Under interior slab-on-grade, and foundation elements, scarify native subgrade surface to a minimum of twelve (12) inches, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density. Provide 12 inches of imported fill under all ABC and concrete slabs on grade per Soils Report.
- C. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

3.05 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Under exterior slab-on-grade (pavements), excavate surfaces to indicated cross sections, elevations, and grades. Scarify native subgrade surface to a minimum of eight (8) inches, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

3.06 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations. Verify and record pipe locations, inverts and elevations prior to backfilling of trenches.
 1. Excavate trenches to uniform widths to provide a working clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
- B. Trench Bottoms: Beyond building perimeter, excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter and flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe circumference. Fill depressions with sand backfill.
3. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.07 APPROVAL OF SUBGRADE

- A. Notify Geotechnical Engineer when excavations have reached required subgrade.
- B. If Geotechnical Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
 1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.
- D. Reconstruct subgrades damaged by rain, accumulated water, or construction activities, as directed by Geotechnical Engineer.

3.08 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Engineer.
 1. Fill unauthorized excavations as directed by Soils Engineer.

3.09 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover or water to prevent windblown dust.

3.10 BACKFILL

- A. Use only approved fill material for backfill. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Construction below finish grade including, where applicable, damp-proofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for record documents.
 3. Inspecting and testing underground utilities.
 4. Removing trash and debris.
 5. Removing temporary shoring and bracing, and sheeting.

3.11 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Backfill trenches excavated under footings and within 24 inches of bottom of footings; fill with concrete to elevation of bottom of footings.

- C. Provide 8-inch- thick, concrete-encasement support for piping or conduit less than 30 inches below surface of roadways and driveways.
- D. Place and compact initial backfill of subbase material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit.
 - 1. Carefully compact material under pipe haunches and bring backfill evenly up on both sides and along the full length of piping or conduit to avoid displacement of utility system.
- E. Place backfill and fill materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches in loose depth for material compacted by hand-operated tampers.
- F. Place and compact final backfill of satisfactory soil material to final subgrade.
- G. Coordinate backfilling with utilities testing and inspections.

3.12 FILL

- A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory top-soil material.
 - 2. Under walks and pavements, use satisfactory on-site soil material.
 - 3. Under building slabs, use imported select fill.
 - 4. Under footings and foundations, use imported select fill.

3.13 MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill layer before compaction to within 2 percent of optimum moisture content.
 - 1. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF BACKFILLS AND FILLS

- A. Compact soil to not less than the following percentages of maximum dry density according to ASTM D 698:
 - 1. Building Pad: Under structures, building slabs and footings of newly excavated subgrade, the soil surface shall be scarified to a minimum depth of six inches, moisture added as required to bring moisture content to within the allowed range of optimum, and recompact to a minimum density as required. Select fill shall be placed in successive horizontal layers of not more than 10 inches in loose depth for the full width of the building cross-section. Compact each layer of backfill or fill material to 95 percent. See Soils Report for additional requirements.
 - a. Areas to receive select fill shall be cleared of all organic and other deleterious material.
 - b. Each layer of select fill shall be uniform as to material, density and moisture content before beginning compaction. Where layers of unlike materials about each other, each layer shall be fed or the material shall be so mixed as to prevent abrupt changes in the soil.
 - c. Wetting or drying of the material and manipulation when necessary to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, work on all portions of the select fill thus affected shall be delayed until the material has dried to the required moisture content.
 - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 92 percent.
 - 3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material at 85 percent.

3.15 GRADING

- A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 - 2. Walks: Plus or minus 1 inch.
 - 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1 inch when tested with a 10-foot straightedge.
- D. Landscape Areas: Fine grade landscape areas to a smooth, even surface with loose, uniformly fine texture. Roll, rake and drag lawn areas, remove ridges and fill depressions, as required to meet finish grades. Limit fine grading to areas which can be planted immediately after grading. Finish areas to receive topsoil to within not more than 0.10' above or below required subgrade elevations. Place and compact a minimum of 3" of satisfactory topsoil and fine grade.
 - 1. Finish grade of topsoil to be 1" below all tops of curbs and 1" below all tops of sidewalks.
 - 2. Place all topsoil to maintain a positive slope away from all buildings.
 - 3. Provide berms and contours as shown on landscape drawings.

3.16 SUBBASE COURSE

- A. Under pavements, place subbase course on prepared subgrade and as follows:
 - 1. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
 - 2. Shape subbase to required crown elevations and cross-slope grades.
- B. Pavement Shoulders: Place shoulders along edges of subbase to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.17 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison when approved by Engineer.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 5000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for each 150 feet or less of wall length, but no fewer than two tests.
 - 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench length, but no fewer than two tests.

- D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace soil material to depth as directed by Engineer.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION

SECTION 31 31 20

SOIL TREATMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Soil pretreatment to provide chemical barrier to termite infestation adjacent to and under building slabs.

1.02 SUBMITTALS

- A. Product Data: Treatments and application instructions, including EPA-Registered Label.
- B. Warranties: Special warranties specified in this Section.

1.03 QUALITY ASSURANCE

- A. Applicator Qualifications: An applicator who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment in jurisdiction where Project is located and who is experienced and has completed termite control treatment similar to that indicated for this Project and whose work has a record of successful in-service performance.
- B. Regulatory Requirements: Formulate and apply termiticides, and label with a Federal registration number, to comply with EPA regulations and authorities having jurisdiction.

1.04 PROJECT CONDITIONS

- A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated. Do not treat soil while precipitation is occurring or anticipated. Comply with EPA-Registered Label requirements and requirements of authorities having jurisdiction.
- B. Coordinate soil treatment application with excavating, filling, and grading and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs, before construction.

1.05 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty:
 - 1. Termite Warranty: Written warranty, signed by applicator and Contractor certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
- C. Warranty Period:
 - 1. Termite Warranty Period: Five years from date of application.

- D. Continuing Service: Provide for continuing service, including monitoring, inspection, and retreatment for occurrences of termite activity, for the warranty period, starting on the date of Substantial Completion.

PART 2 - PRODUCTS

2.01 SOIL TREATMENT

- A. Termite Treatment: Provide an EPA-registered termiticide complying with requirements of authorities having jurisdiction, in a soluble or emulsible, concentrated formulation that dilutes with water or foaming agent, and formulated to prevent termite infestation. Use only soil treatment solutions that are not harmful to plants. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to the product's EPA-Registered Label.
 - 1. Approved Manufacturers:
 - a. Dragnet SFR (Permethrin); FMC Corporation.
 - b. Prelude (Permethrin); Amvac Chemical Corp.
 - c. Masterline 7.9 (Bifenthrin); Univar Environmental.
 - d. Talstar (Bifenthrin); FMC Corporation.
 - e. Premise 75 (Imidacloprid); Bayer Environmental.
 - f. Dominion 2L (Imidacloprid); Control Solutions, Inc.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, and conditions, with Applicator present, for compliance with requirements for moisture content of the soil, interfaces with earthwork, slab and foundation work, landscaping, and other conditions affecting performance of termite control.

3.02 PREPARATION

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparing substrate. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Termiticides may be applied before placing compacted fill under slabs if recommended by termiticide manufacturer.

3.03 APPLICATION, GENERAL

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.04 TERMITICIDE APPLICATION

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal

and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute the treatment evenly.

1. Slabs-on-Grade: Ground-supported interior building slabs for a width of 15'-0". Treat soil materials before concrete slabs are placed.
 2. Foundations: Adjacent soil including soil along perimeter walls, around plumbing pipes and electric conduit penetrating perimeter walls below grade, and along entire outside perimeter for a width of 5'-0".
 3. Trenches: Top 24 inches of trench.
 4. Masonry: Treat voids.
- B. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- C. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
- D. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION

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SECTION 32 12 16

ASPHALT PAVEMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. On-site hot-mix asphalt paving.
 - 2. Hot-mix asphalt patching.
- B. Related Sections include the following:
 - 1. Section 31 20 00 for "Earthwork" for aggregate subbase and base courses and for aggregate pavement shoulders.
 - 2. Section 32 17 23 for "Traffic Marking Paint" for pavement markings.
 - 3. Section 32 13 13 for "Site Concrete Paving" for decorative concrete paving.
 - 4. Section 07 92 00 for "Joint Sealers" for joint sealants and fillers at paving terminations.

1.02 SYSTEM DESCRIPTION

- A. Provide hot-mix asphalt paving in compliance with materials, workmanship, and other applicable requirements of PPRAP standard specifications.
 - 1. Mix-Design: Grading SX

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated, include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification of approval of each job mix proposed for the Work.

1.04 QUALITY ASSURANCE

- A. Codes and Standards: Comply with applicable provisions of the following codes, specifications and standards, unless more stringent provisions are indicated or specified:
 - 1. Pikes Peak Region Asphalt Paving Specifications – Version 6

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver asphalt mixture to jobsite to maintain minimum temperature of 250 degrees.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
 - 1. Prime and Tack Coats: Minimum surface temperature of 60 deg F.
 - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 - 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

- B. Grade Control: Establish and maintain required sub-base lines and elevations to maintain uniform pavement thicknesses and grades.

PART 2 - PRODUCTS

2.01 AGGREGATES

- A. General: Use locally available materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone or crushed gravel.
- C. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, properly cured blast-furnace slag, or combinations thereof.
- D. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.
- E. Aggregate Base Course: Class 6 per Section 703.03 of the CDOT Standard Specifications.

2.02 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO MP 1, PG 64-22.
- B. Asphalt Cement: ASTM D 3381 for viscosity-graded material, PG 70-10.
- C. Water: Potable.

2.03 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes in conformance with Table 2.06 of PPRAP standard specifications.
 - 1. Approved Mix: Grading SX.
 - 2. Asphalt: minimum 5% by volume.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.02 PATCHING

- A. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

- B. Patching: Fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact flush with adjacent surface.

3.03 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

3.04 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place hot-mix asphalt base course in thicknesses indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at minimum temperature of 250 deg F.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.05 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Compact joints as soon as asphalt will bear roller weight without excessive displacement.

3.06 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement.
 - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 96 percent of reference laboratory density according to AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
- D. Finish Rolling: Finish rolled surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh asphalt. Compact by rolling to specified density and surface smoothness.

3.07 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/4 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within 1/4 inch in a 10-foot straightedge applied transversely or longitudinally to paved areas.

3.08 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and to prepare test reports to confirm thicknesses and densities.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

SECTION 32 13 13

SITE CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes exterior concrete pavements for the following:
 - 1. Driveways and roadways.
 - 2. Curbs and gutters.
 - 3. Integral-color concrete sidewalks and walkways.
 - 4. Exposed-aggregate concrete sidewalks and walkways.
 - 5. Light-broom finish sidewalks and walkways.
 - 6. Truck-dock aprons.
- B. Related Sections include the following:
 - 1. Section 31 20 00 for "Earthwork" for sub-grade preparation, grading, and sub-base course.
 - 2. Section 03 30 00 for "Cast-in-Place Concrete" for general building applications of concrete.

1.02 RELATED DOCUMENTS

- A. Refer to soil and pavement recommendations of the Project Soils Report listed in Document 00880 "Soils Investigation Data".

1.03 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed pavement 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.
- B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- C. Regulatory Requirements: Comply with local code and regulatory requirements for accessible design and the following:
 - 1. 2010 – "ADA Standards for Accessible Design".
- D. Mockups: Before installing special finish pavements, build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups using materials indicated for the completed Work:
 - 1. Build mockups for in sizes approximately 48 inches long by 96 inches long.
 - 2. Approval of mockups is for color, texture, and blending of special finish pavements. Maintain mockups during construction in an undisturbed condition as a standard for comparing the completed Work. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.05 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required in the public right-of-way or for other construction activities.

PART 2 - PRODUCTS

2.01 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
- B. 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.

2.02 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- B. Reinforcement Bars: ASTM A 615, Grade 60, deformed.
- C. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615, Grade 60, deformed bars; assembled with clips.
- D. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place.

2.03 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type II, alkali content not to exceed 0.6 percent.
- B. Fly Ash: ASTM C 618, Class F, proportioned in accordance with ACI 232-4.1. Combined fly ash, silica fume or other pozzolans shall not exceed the following percentages of cement by weight:
 - 1. Slabs-on-Grade: 15 percent.
 - 2. Integral-Color Slabs-on-Grade: Not allowed.
 - 3. Drives, Curbs and Gutters: 25 percent.
- C. Aggregate: ASTM C 33, uniformly graded, not less than Class 1N coarse aggregate, free of substances with deleterious reactivity to alkali in cement.
 - 1. Nominal Maximum Course Aggregate Size: 1 1/2 inches.
 - 2. Fine Aggregate: Clean, washed, sand and gravel, from same source as course aggregate.
- D. Exposed Aggregate: Uniformly gap-graded, not less than 65% of total aggregate volume, free of substances with deleterious reactivity to alkali in cement.
 - 1. Nominal Aggregate Size: 3/8-inch river-run smooth pea-gravel aggregate.
 - 2. Fine Aggregate: Clean, washed, sand and gravel, from same source as course aggregate.
- E. Water: ASTM C 94, potable.

2.04 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.

- B. Air-Entraining Admixture: ASTM C 260, compatible with other admixtures.
- C. Exposed Aggregate Concrete Retarder: Water-based spray-applied top-cast surface retarder, designed to retard the hydration of the surface layer of cement, producing a finish that exposes the fine aggregates to a average depth of 1/8-inch. Acceptable products include:
 - 1. Rugasol-S; Sika Corporation.
 - 2. Top-Stop Horizontal; W.R. Meadows, Inc.
 - 3. Top-Cast; Grace Construction Products.
- D. Coloring Agent: ASTM C 979, synthetic mineral-oxide powdered pigments; color stable, non-fading, and resistant to lime and other alkalis. Limit ratio of color agent to 10% of cementitious materials by weight. Basis-of-Design product:
 - 1. Mix-Ready; Davis Colors.
 - a. Sandstone 5237; minimum 0.75 lbs per 94 lbs cement.

2.05 CURING MATERIALS

- A. Exterior Curing and Sealer: Clear, self-dissipating, waterborne, membrane-forming curing and sealing compound ASTM C 1315, Type 1, Class B. Acceptable products include:
 - 1. Vocomp 30; W. R. Meadows, Inc.
 - 2. Dress & Seal 30; L&M Construction Chemicals, Inc.
 - 3. Kure-N-Seal 30; BASF Construction Chemicals.

2.06 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C 1059, 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 and grade to suit requirements.
- D. Expansion Joint Filler Strips: At slabs abutting vertical elements or other cold-joints, ASTM D 1751, cellulosic-foam; 1/2-inch thick with removable cap-strip cover for subsequent application of sealant. Acceptable Products include:
 - 1. Snap-Cap; W. R. Meadows, Inc.
 - 2. Normaflex; Nomaco.
- E. Pavement Markings: As specified in Section 32 17 23 "Traffic Marking Paint".

2.07 CONCRETE MIXES

- A. Prepare design mixes, proportioned according to ASTM C 94 and ASTM C 1116, for each type and strength of concrete determined by laboratory trial mixes. Proportion mixes with the following properties:
- B. Walkways, Sidewalks and Stairs: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 3000 psi.
 - 2. Maximum Slump: 4 inches.
 - 3. Maximum Water-Cementitious Materials Ratio: 0.50.
 - 4. Air-Entrainment: 4 percent, plus or minus 1 1/2 percent.
- C. Exposed Aggregate Driveways: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 3000 psi.
 - 2. Maximum Slump: 4 inches.
 - 3. Maximum Water-Cementitious Materials Ratio: 0.50.
 - 4. Air-Entrainment: 3 percent, plus or minus 1 1/2 percent.

- D. C.I.P. Curbs and Gutters: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 3000 psi.
 - 2. Maximum Slump: 4 inches.
 - 3. Maximum Water-Cementitious Materials Ratio: 0.48.
- E. Driveways and Truck-Courts: Proportion normal-weight concrete mix as follows:
 - 1. Compressive Strength (28 Days): 3500 psi.
 - 2. Maximum Slump: 4 inches.
 - 3. Maximum Water-Cementitious Materials Ratio: 0.50.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Compact subbase surfaces to eliminate unstable areas. Proceed with pavement only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.
 - 1. Remove loose material from compacted subbase surface immediately before placing concrete.

3.02 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

3.03 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for reinforcement.
- B. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- C. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- D. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 6-inch overlap to adjacent mats.

3.04 JOINTS

- A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of pavement, unless pavement terminates at isolation joints.
- C. Isolation Control Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
 - 1. Locate sidewalk expansion joints at intervals of 20 feet unless otherwise indicated.
 - 2. Locate curb and gutter expansion joints at intervals of 20 feet unless otherwise indicated.
 - 3. Extend joint fillers full width and depth of joint, but not less than 1/2 inch or more than 1 inch below finished surface for joint sealant application.

- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving tool marks on concrete surfaces.
- E. Sawed Joints: Form contraction joints with power saws equipped with 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 developing random contraction cracks. Cut joints 1/3 of overall slab depth.
- F. Edging: Tool edges of gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces. Provide 3/8 inch radius edges.
- G. Sealants: At isolation and expansion joints provide sealant per Section 07 92 00 "Sealants". Dust traffic joints with mica sand before sealant has formed a skin.

3.05 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to 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.
- C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- D. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping.
- E. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

3.06 CONCRETE FINISHING

- A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 - 2. Truck-Dock Aprons: Produce a uniform, heavy-to-medium, textured broom finish by drawing a soft bristle broom across float-finished concrete surface, perpendicular to dock doors.

3.07 SPECIAL FINISHES

- A. Exposed Aggregate Finish: Expose gravel aggregate to pavement surfaces as follows:

1. Screed to very flat surface with bull-float and roller-tamp surface to consolidate surface aggregates.
 2. After finishing and removal of bleed water, spray-apply chemical surface retarder to pavement surfaces according to manufacturer's written instructions to produce a penetration depth of 1/16 inch, or equivalent "acid-etched" appearance, matching approved site mock-up samples.
 3. Cover with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
 4. Within 12 hours, remove excess mortar by lightly brushing surface with a stiff, nylon bristle broom and water, to produce a uniform depth of exposed aggregate. Repeat water flushing and brushing cycle until cement film is removed from aggregate surfaces to depth required.
 5. Curing: Upon completion of brushing and removal of retarder, apply curing compound.
- B. Protection: Protect special finish concrete slabs from damage by covering with a sand protection layer and cover boards at door entrances and under scaffolding.

3.08 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive hot temperatures. Comply with ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause excessive moisture loss during finishing operations.
- C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.
- D. 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.

3.09 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
1. Elevation: 1/4 inch.
 2. Thickness: Plus or minus 1/4 inch.
 3. Surface: Gap below 10-foot long, unleveled straightedge not to exceed 1/4 inch.
 4. Joint Spacing: 3 inches, plus or minus.
- B. At accessible ramps and sidewalk routes, comply with regulatory requirements for accessible design tolerances and as follows:
1. Elevation: Plus or minus 1/8 inch.
 2. Surface: Gap below 10-foot long straightedge not to exceed 1/8 inch.
 3. Ramp Slopes and Cross-Slopes: plus or minus 1/16 inch in 12 inches, not exceeding 1/8 inch in 5 feet.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement.
- B. Testing Services: Testing shall be performed according to the following requirements:
1. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
 2. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 50 cu. Yd. One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.
- C. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain design compressive strength at

28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.
- B. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep and power wash concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

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SECTION 32 17 23

TRAFFIC MARKING PAINT

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following traffic markings at locations as shown on Drawings.
 - 1. Fire-lane curbs.
 - 2. Car parking stall striping.
 - 3. Truckcourt parking stall striping.
 - 4. ADA accessibility designations.
- B. Related Sections include the following:
 - 1. Section 32 12 16 – “Asphalt Paving” for pavement mix-designs.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's product specification and installation instructions for marking paint.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with local code and regulatory requirements for accessible design and the following:
 - 1. 2010 – “ADA Standards for Accessible Design”.
 - 2. City of Colorado Springs Regulations.

1.04 COORDINATION

- A. Coordinate paint applications with final cleaning of exterior pavements.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, with pigment solids by weight of not less than 55%, complying with FS TT-P-1952, Type II, with drying time of less than 15 minutes.
- B. Approved Manufacturers:
 - 1. Zoneline 11-3 Series; PPG Architectural Coatings.
 - 2. Techline; US Specialty Coatings.
 - 3. Fast Dry EF Series; Ennis-Flint.
 - 4. Pro-Park; Sherwin-Williams.
- C. Paint Colors:
 - 1. Fire Lane Curbs Red
 - 2. Parking Spaces White
 - 3. Handicapped Parking Symbol White/Blue
 - 4. Handicapped Aisle Striping White

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify pavements have been accepted and approved prior to beginning paint applications or layouts.

3.02 PREPARATION

- A. Preparation: Locate markings as shown on Drawings and required by Fire Dept. Provide qualified technician to supervise equipment and application of markings. Lay out markings using guide lines, templates, and forms.
- B. Thoroughly clean surfaces free of dirt, sand, gravel, oil and other foreign materials.

3.03 APPLICATION

- A. General: Apply marking paint at rate of one gallon per 100 sq. ft. or approximately 300 lineal feet of 4 in. wide stripe.
- B. Apply marking paint straight and uniform.
- C. Keep off painted areas until completely dry.

END OF SECTION

SECTION 32 31 19

ORNAMENTAL METAL FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Sliding gates and related hardware.
 - 2. Gate operators.

1.02 SUBMITTALS

- A. Product Data: Material descriptions, construction details, dimensions of individual components and profiles, and finishes for the following:
 - 1. Fence and gate posts, rails, and fittings.
 - 2. Gates and hardware.
 - 3. Gate operators, including operating instructions.
 - 4. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
- B. Shop Drawings: Show locations of fence, each gate, posts, rails, and tension wires and details of extended posts, extension arms, gate operation, hardware, and accessories. Indicate materials, dimensions, sizes and finishes of components. Include plans, elevations, sections, gate swing and other required installation and operational clearances, and details of post anchorage and attachment and bracing.
 - 1. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, mounting, and grounding provisions.
 - 2. Wiring Diagrams: Indicate manufacturer-installed and field-installed wiring power and control wiring provided by gate operator manufacturer and those provided by others.
- C. Product Certificates: Signed by manufacturers of fences and gates certifying that products furnished comply with requirements.
- D. Maintenance Data: Include in maintenance manuals for gate operator.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Field Measurements: Verify actual locations of structural supports for fence and gate panels by field measurements before fabrication and indicate measurements on Shop Drawings.
- D. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating fence and gate panels without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.01 STEEL

- A. Plates, Shapes, and Bars: ASTM A 36.
- B. Tubing: ASTM A 500, cold formed steel tubing.
- C. Bars: Hot-rolled steel strip, ASTM A 1011, Commercial Steel, Type B.

2.02 COATING MATERIALS

- A. Shop Primers for Steel: Provide primers that comply with Section 09 91 13 "Exterior Painting."

2.03 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section for "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.
- C. Nonshrink Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107 and specifically recommended by manufacturer for exterior applications.

2.04 VEHICULAR HORIZONTAL SLIDE GATES

- A. General: Comply with ASTM F 1184 for the following slide-gate types:
 - 1. Double gate.
 - 2. Classification: Class 1 Overhead Slide.
- B. Frames and Bracing: Fabricate members from steel tubing as follows:
 - 1. Leaf Width and Height: As indicated on Drawings.
 - 2. Intermediate Frame Members: Minimum 1/4" x 3" x 3" square tubing.
 - 3. Perimeter Frame Members: Minimum 1/4" x 3" x 3" square tubing.
- C. Gate Panels: 3/4" x 3/4" x 16 ga. square tubing pickets at 4-inches o.c.
- D. Frame Corner Construction:
 - 1. Type I Overhead Slide Gates: Welded or assembled with corner fittings including 5/16-inch-diameter, adjustable truss rods for panels 5 feet wide or wider.
- E. Overhead Track Assembly: Manufacturer's standard heavy-duty track, with overhead framing supports, ball-bearing hanger sheaves, guide stays, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.
- F. Hardware: Latches permitting operation from both sides of gate, locking devices hangers roller assemblies and stops fabricated from galvanized steel. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
- G. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

2.05 GATE OPERATORS

- A. General: Provide factory-assembled automatic gate operation system designed for gate size, type, weight, construction, use, traffic-flow patterns, and operation frequency. Provide operation system of size and capacity and with features, and accessories suitable for safe operation and duty-cycles as recommended by gate manufacturer complete with electric motor and factory-prewired motor controls, remote-control stations, control devices, power disconnect switch, obstruction detection device,

lockable weatherproof enclosures protecting controls and all operating parts, and accessories required for proper operation.

1. Provide enclosures with corrosion-resistant-protective and decorative finish.
 2. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
 3. Coordinate operator wiring requirements and electrical characteristics with building electrical system. Include wiring from motor controls to motor.
- B. 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. Slide Gates: (AC voltage)
 - a. All-O-Matic: SL-150. (1/2hp)
 - b. Liftmaster: SL3000UL (1/2hp)
 - c. Viking: L-3. (1/2hp)
- C. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70, Class 2 control circuit, maximum 24V ac or dc.
- D. Electromechanical Operation: Provide unit designed for gate and concrete base/pad; consisting of electric motor and factory-prewired motor controls, starter, speed control device, chain-drive assembly, clutch or torque limiter, and as follows:
1. V-belt and worm gear chain and sprocket reducers, roller chain drive.
 2. Enclosed worm gear reducer, wheel and rail drive.
- E. Operation Cycle Requirements: Design gate operator to operate for not less than the following duty and cycles per hour. One cycle equals one gate opening plus one gate closing.
1. Heavy Duty: 25 cycles per hour.
 2. Sliding Gate Operation Speed: Minimum 60 fpm.
- F. Electric Motors: Reversible, continuous-duty, insulated electric motors, complying with UL325, sized to start and operate gate leaf of lengths indicated.
1. Sliding Gate Leaf Weight: 1800 lbs.
- G. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 1 enclosure for surface concrete base/pad mounting, and with space for additional optional equipment. Provide the following remote-control device(s):
1. Control Station: Momentary-contact, single-button-operated control station with open and close functions.
 2. Digital Keypad Entry Unit: Functions only when authorized code is entered. Multiple-code capability.
- H. Vehicle Loop Detector System: System including automatic closing timer with adjustable time delay timer cut-off switch and loop detector designed to open and close gate, hold gate open until traffic clears and reverse gate. Provide electronic detector, with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide multi-strand wire for pave-over installation.
- I. Obstruction Detection Devices: Provide each motorized sliding gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
1. Action: Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction.
 2. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in partition's path by interruption of an infrared beam in the zone pattern without obstruction contacting gate.
- J. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.
- K. Operating Features: Include the following:
1. Master/Slave Capability: Control stations designed and wired for double gate pair operation.
 2. Automatic Closing Timer: With adjustable time delay before closing.

- L. Accessories: Include the following:
 - 1. Call-Box Mounting kit including pedestal.
 - 2. Battery Backup System: Battery-powered drive and access control system, independent of primary drive system, opening gate if power fails.
 - 3. Pre-Emption Detectors: Tomar 1790 or equal as approved by local AHJ.
 - 4. Fire Dept. Knox box: Knox Model 3502 keyswitch or equal as approved by local AHJ.

2.06 CAST-IN-PLACE CONCRETE

- A. Materials: Portland cement complying with ASTM C 150, Type I aggregates complying with ASTM C 33, and potable water for ready-mixed concrete complying with ASTM C 94.
 - 1. Concrete Mixes: Normal-weight concrete with not less than 3000-psi compressive strength.
- B. Materials: Dry-packaged concrete mix complying with ASTM C 387 for normal-weight concrete mixed with potable water according to manufacturer's written instructions. Dry-packaged concrete mix may be used meeting minimum strength requirements as noted.
- C. Concrete Bases/Pads: Cast-in-place or precast concrete, made of not less than 3000-psi compressive strength (28 days), depth not less than 12 inches, dimensioned and reinforced according to gate operator component manufacturer's written instructions.
- D. Post Footings: Footings shall be 3,000 psi after twenty-eight (28) days concrete. Diameter and depth of footings shall be as follows, unless otherwise indicated on the Drawings.
 - 1. 3-inch square post: Min. 12" dia., 36" in depth.
 - 2. 4-inch square post: Min. 12" dia., 36" in depth.
 - 3. 6-inch square post: Min. 18" dia., 48" in depth.
 - 4. 8-inch square post: Min. 24" dia., 48" in depth.

2.07 STEEL FINISHES

- A. Painted Finish: Clean surfaces according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 1. Primer Application: Apply zinc-rich epoxy primer immediately after cleaning, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that will be exposed after assembly and installation, and to concealed surfaces.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.
- B. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage.

3.03 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

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