



PROJECT MANUAL

SABINE RIVER AUTHORITY
LAKE TAWAKONI TOURNAMENT FACILITY
RESTROOM, HARDSCAPE, AND LANDSCAPE
Van Zandt, Texas

ISSUE FOR BIDDING
September 8, 2022

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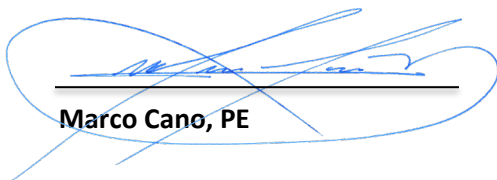
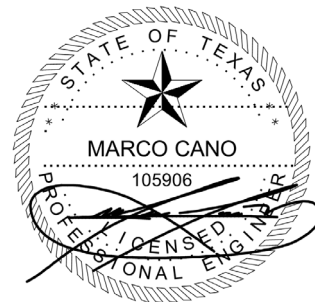


September 8, 2022

Lake Tawakoni Tournament Facility – Restroom, Hardscape and Landscape
FRACTAL Project # 20-014-00

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Marco Cano, PE

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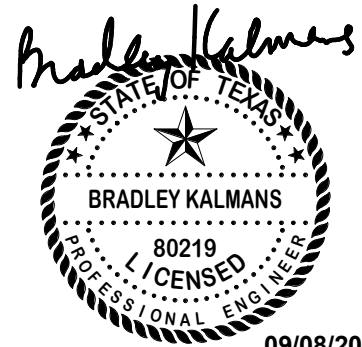
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DOCUMENT 00 3132 - GEOTECHNICAL DATA

1.1 GEOTECHNICAL DATA

- A. This Document with its referenced attachments is part of the Procurement and Contracting Requirements for Project. They provide Owner's information for Bidders' convenience and are intended to supplement rather than serve in lieu of Bidders' own investigations. They are made available for Bidders' convenience and information. This Document and its attachments are not part of the Contract Documents.
- B. Because subsurface conditions indicated by the soil borings are a sampling in relation to the entire construction area, and for other reasons, the Owner, the Architect, the Architect's consultants, and the firm reporting the subsurface conditions do not warranty the conditions below the depths of the borings or that the strata logged from the borings are necessarily typical of the entire site. Any party using the information described in the soil borings and geotechnical report shall accept full responsibility for its use.
- C. A geotechnical investigation report for Project, prepared by E TTL Engineers & Consultants, Inc., dated May 19, 2021, is available for viewing as appended to this Document.
 - 1. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.
 - 2. Any party using information described in the geotechnical report shall make additional test borings and conduct other exploratory operations that may be required to determine the character of subsurface materials that may be encountered.

END OF DOCUMENT 00 3132

Geotechnical Investigation

Lake Tawakoni Holiday Marina Wills Point, TX

ETTL Project G5378-20

Rev.	Date	Reason for Revision	By	Check	P.E.
01	4-6-2020	Revised pavement recommendations			SR



ETTL Engineers & Consultants Inc.

GEOTECHNICAL * MATERIALS * ENVIRONMENTAL * DRILLING * LANDFILLS

April 6, 2020

Steve Hobbs, P.E.
LJA Engineering
2929 Briarpark Drive, Suite 600
Houston, Texas 77042

Re: Lake Tawakoni, Wills Point, TX
Proposed Holiday Marina
Geotechnical Investigation
ETTL Job No. G5378-20

Dear Steve:

Submitted herein is our report summarizing the results of a geotechnical investigation conducted at the site of the above-referenced project.

If you have any questions concerning this report, or if we can be of further assistance during construction, please contact us. We are available to perform any construction materials testing and inspection services that you may require. Thank you for the opportunity to be of service.

Sincerely,
ETTL Engineers & Consultants Inc.
Texas Registered Professional Engineering Firm #F3208

Stephen R, Richards, P.E.
Principal Consultant



April 6, 2020

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Geotechnical Investigation

Lake Tawakoni

Holiday Marina

Wills Point, TX

ETTL Project G5378-20

Submitted to

Steve Hobbs, P.E., LJA Engineering
Houston, TX

Prepared by

ETTL Engineers & Consultants Inc.
Tyler, Texas

April 2020

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- Laboratory Test Data Summary Sheets
- Unconsolidated/Undrained Triaxial Compression
- One-Dimensional Swell

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1.0 INTRODUCTION

This study was performed at the request and authorization to proceed granted by Mr. James D. Ross, LJA Engineering, Houston, TX in accordance with our proposal dated February 12, 2020. Field operations were conducted March 2, 2020.

The purpose of this investigation was to define and evaluate the general subsurface conditions at the location of the proposed Holiday Marina on Lake Tawakoni, Wills Point, TX. Specifically, the study was planned to provide the following information:

- Subsurface stratigraphy within the limits of exploratory borings;
- Classification, strength, expansive properties, and compressibility characteristics of the foundation soils;
- Suitable foundation types and recommended allowable loadings;
- Generic pavement recommendations for the proposed parking and drives; and,
- Construction-related issues that may be anticipated by the investigation.

The investigation was carried out in three phases: 1) field exploration, sampling and testing; 2) laboratory testing; and 3) engineering evaluation of data, the details of which are set forth in the following sections.

A variety of tests were performed on selected soil samples to provide the data used to form the basis for the conclusions and recommendations of this study. These tests were conducted to classify the soil strata according to a widely used engineering classification system; identify, and provide quantitative data for active (expansive) soils; define strength characteristics relating to allowable bearing values; predict settlement characteristics; and assess construction workability of the soils.

The conclusions and recommendations that follow are based on limited information regarding proposed site grading. E TTL located the borings on the ground utilizing hand-held GPS equipment based on a site plan provided by others.

2.0 PROJECT DESCRIPTION

The project consists of a new three-lane boat ramp, restroom and pavilion at the existing Lake Tawakoni Holiday Marina, Wills Point, Texas. New parking and driveway are also part of the new development.



3.0 SITE DESCRIPTION

Several structures have recently existed in or near the proposed structure footprints. We understand that these structures were removed with the exception of a foundation, existing boat ramp and road.

4.0 FIELD OPERATIONS

4.1 Geotechnical Drilling

Subsurface conditions at the sites of proposed structures were defined by borings drilled to depths varying from 15' to 20'. Twelve borings were drilled to a depth of 5' in the proposed parking area and entry road. Borings were marked in the field by E TTL personnel using hand-held GPS equipment. The boring locations are shown on the Boring Plan included in **APPENDIX A**. The field boring logs were prepared as drilling and sampling progressed. Final boring logs (**APPENDIX A**) were prepared based on examination of soil samples by a geotechnical engineer as well as on soil test results. Descriptive terms and symbols used on the logs are in accordance with the Unified Soil Classification System (ASTM D 2487). A reference key is provided at the end of **APPENDIX A**.

A track-mounted drill rig was mobilized for this project using flight auger drilling procedures to advance the borings. Soils were sampled by means of a 1 3/8-inch I.D. by 24-inch long split-spoon sampler driven into the bottom of the borehole in accordance with ASTM D 1586 procedures using an automatic hammer. In conjunction with this sampling technique, the Standard Penetration Test was conducted by recording the N-value, which is the number of blows required by a 140-pound weight falling 30 inches to drive a split-spoon sampler 1 foot into the ground. For very dense strata, the number of blows is limited to a maximum of 50 blows within a 6-inch increment. Where possible, the sampler is "seated" six inches before the N-value is determined. The N-value obtained from the Standard Penetration Test provides an approximate measure of the relative density that correlates with the shear strength of soil. The blow count obtained was multiplied by 1.25 to conservatively convert the N values from the automatic hammer to the standard N_{60} value for use in correlations to predict engineering properties ($N_{60} \leq 100$). The disturbed samples were removed from the sampler, logged, packaged, and transported to the laboratory for further identification and classification.

Soils were also sampled by means of a 3-inch O.D. by a 24-inch long Shelby Tube sampler. Using the drilling rig's hydraulic pressure, the sampler was pushed smoothly into the bottom of the borehole. The consistency of these samples was measured in the field by a calibrated pocket penetrometer. These values, recorded in tons per square foot, are shown on the boring logs. Such samples were sealed to maintain *in situ* conditions, and packaged for transport to the laboratory where they were extruded and logged.

All boreholes were backfilled with cuttings after collecting final groundwater readings. Samples obtained during our field studies and not consumed by laboratory testing procedures will be



retained in our Tyler office free of charge for a period of 60 days. To arrange storage beyond this point in time, please contact the Tyler office.

5.0 LABORATORY TESTING

Upon return to the laboratory, a geotechnical engineer visually examined all samples and specimens were selected for representative identification of the soil profile. By determining the Atterberg liquid and plastic limits (ASTM D 4318) and percentage of fines passing the No. 200 sieve (ASTM D 1140), field classification of the various strata was verified. Also conducted were natural moisture content tests (ASTM D 2216). The number and type of tests performed for this study are listed in the table below. Details of the tests can be found in **APPENDIX B**.

5.1 Unconsolidated/Undrained Triaxial Compression

Strength and deformation characteristics of the cohesive strata were evaluated by conducting unconsolidated, undrained triaxial compression tests (ASTM D 2850) on selected field samples obtained with the Shelby tube sampler. In this type of compression test, confining pressures were chosen that approximate in situ effective pressures at the sample depth below existing ground and specimens were tested at in situ moisture content. The specimens were axially loaded until failure occurred. The undrained shear strength (or cohesion) is equal to one-half the peak compressive stress. In hard clays, it is very difficult to obtain specimens while maintaining the in situ condition representative of the clay mass. This phenomenon is taken into account when evaluating test data from such specimens. Moisture content (ASTM D 2216) and dry density (ASTM D 2437) are determined as part of this test. The results of the tests mentioned above are presented on the individual log of boring in **APPENDIX A** and summarized in **APPENDIX B**. Details regarding triaxial tests are also included in **APPENDIX B**.

5.2 One Dimensional Swell

Pressure-swell testing (ASTM D 4546 Methods A & B (mod)) was performed by adding moisture to a specimen and observing the amount of pressure necessary to restrain swelling. In some cases the specimen is dried from its natural moisture content to about 2% below the plastic limit moisture content to evaluate the potential swell under relatively dry conditions. After the pressure has stabilized, the restraining pressure is removed and the specimen is allowed to swell and the total primary free-swell is recorded following a period of up to 96 hours.

A listing of all tests conducted is provided in the table below:



Table 5.0.1 – Soil Laboratory Testing Procedures		
Test	Test Method	Number of Tests
Sieve Analysis (Passing No. 4)	ASTM D 1140	15
Sieve Analysis (Passing No. 40)	ASTM D 1140	15
Sieve Analysis (Passing No. 200)	ASTM D 1140	15
Atterberg Limits (Liquid & Plastic Limits)	ASTM D 4318	15
Moisture Content	ASTM D 2216	15
One-Dimensional Swell	ASTM D 4546	2
Unconsolidated/Undrained Triaxial	ASTM D 2850	2

The above laboratory tests were performed in general accordance with applicable ASTM, U.S. Army Corps of Engineers, TxDOT procedures, and/or generally accepted practice. It should be noted that reference to ASTM or other standard procedures does not imply that all cross-referenced procedures in ASTM or other standards have been used, or that all ASTM or other procedures used have been followed exactly. Only those ASTM or other standard procedures and/or portions of procedures, which, in the professional judgment of the geotechnical engineer of record for this report, are applicable, appropriate, and necessary for this particular project, have been used or followed. Details regarding these tests are included on the logs (**APPENDIX A**) and in the Laboratory Test Reports of **APPENDIX B**.

6.0 SOIL STRATIGRAPHY AND PROPERTIES

6.1 Regional Geology

The proposed site is located in an outcrop of the Wills Point (Ewp) formation described as follows:

Upper 100+ feet, clay, medium bluish gray, greenish gray, grayish green, brownish gray, silty increases upward, laminated to locally massive, glauconitic near base, rough calcareous siltstone concretions common in upper part, locally lignitic in upper part, thin bed of rosette limestone near middle; weathers medium gray to yellowish gray; fossiliferous; 500+/- feet thick

For more information please refer to the Texas Geologic Map Database found here:

<https://txpub.usgs.gov/txgeology/>

6.2 Site Stratigraphy

The soils at the site generally consist of strata as described below. The classifications are based on weathering, depositional environment, mineralogy, color change, lithology, and structure. Detailed on the boring logs in **Appendix A** are the specific types and depths of the various soil strata encountered. The logs show defined boundaries between various soil types, but in reality, the transition between types is generally gradual.



- **Stratum 1 (13' thick)**
 - Generally medium stiff to stiff fat clay (CH), except very stiff to hard along entry drive and loop drive in the northeast. Atterberg Plasticity Indices (PI) of the tested soils range from 28 to 63.
- **Stratum 2 (below 13' deep)**
 - Very stiff to very hard fat clay (CH). Atterberg Plasticity Indices (PI) of the tested soils range from 28 to 63.

6.3 Behavior of Expansive Soils

Expansive soils can be any of the following soil types: Clayey Sand (SC), Lean Clay (CL) or Fat Clay (CH), which exhibit the ability to change volume (shrink or swell) with the addition or subtraction of moisture. Expansive soils such as exist throughout the soil profile swell when they absorb moisture and shrink as they dry. Structures placed on these soils move up and down with such volume changes of the soil. When expansive soils are covered by an impermeable surface such as a structure or pavement, seasonal moisture fluctuation at the interior of the covered area tends to be reduced or eliminated due to the lack of exposure to natural wetting and drying conditions (i.e., wind, rain, sun, etc.). At the perimeter of the structure, however, infiltration into the foundation soils from surface drainage could lead to local swelling of the clays (if they were dry at the start of construction) resulting in tilt or distortion of the foundation and/or slab. Where areas immediately adjacent to the structure are paved both the risk of swelling due to excess moisture absorption and shrinkage due to moisture loss are reduced significantly.

At the time of exploration, the moisture content of the expansive clay soils encountered in the surficial 10' in the structure borings was generally moderate to moist. Potential for swelling is considered to be moderate to high under conditions at the time of drilling. Potential for shrinkage is predicted to be moderate to high. As the moisture content of the soil changes from what it was in our samples, the potential for swelling and shrinkage will change accordingly. For example, expansive clays that exhibit swell potential because they are currently dry could swell significantly when exposed to moisture prior to or during construction, lowering further swell potential, but increasing the shrinkage potential.

6.3.1 VERTICAL HEAVE PREDICTIONS

The assessment of the impact of expansive soils given below is predicated on soil moisture change that is a result of normal climatological fluctuation. Factors such as poor drainage, ponding water, plumbing leakage, excavation and foundation details (e.g. permeable backfill in trenches or beneath structures), vegetation and unusual climatic conditions (e.g. excessive drought) can result in moisture changes (and consequent swelling or shrinkage) outside the ranges predicted herein and consequent higher risk of structure distress than what is described herein. The predicted heave is also the predicted differential movement that could be experienced by a slab and/or foundation placed on grade at the existing ground surface.



In attempting to quantify the potential heave, we must make assumptions regarding the moisture content at the time of construction. As noted above, the moisture content of the clay we encountered in the building borings is relatively high and consequently the heave potential is relatively low under current conditions. However, we conservatively assume that soils are in a dry condition at the time of construction in making the predictions below and recommendations for subgrade preparation and foundation type are based on these conservative predictions.

6.3.1.1 Potential Vertical Rise (PVR)

One method for quantifying the potential for subgrade movement at any given location is to calculate the Potential Vertical Rise (PVR) (Tex 124 E Modified). This calculation takes into account the inter-relationship between over-burden pressure, Plasticity Index (PI), and fluctuations in soil moisture. The maximum potential movement of the existing grade (also the predicted maximum differential movement at existing grade level), PVR, due to normal climatological fluctuations in soil moisture content is predicted to be on the order of **4.2 inches at the existing grade**. This is based on assumed dry conditions (at construction) and an estimated annual seasonal moisture fluctuation zone of approximately 10 feet. However, current conditions at this location are generally moist due to a recent prolonged period of wet weather, so, currently, the predicted potential swell is somewhat lower.

6.3.1.2 USACE Potential Vertical Heave (PVH)

Another method for predicting the potential of vertical heave (PVH) of the subgrade soils is the USACE Hand (manual) Method as described in FOUNDATIONS IN EXPANSIVE SOILS (TM 5-818-7, 1983) section 5-4 (See also, EVALUATION OF LEVEL OF RISK FOR STRUCTURAL MOVEMENT USING EXPANSION POTENTIAL, Nelson & Chao, Geo-Frontiers 2001 © ASCE 2011). This method is a prediction of vertical heave based on test results determined from a consolidometer free swell test. These calculations are based on actual moisture conditions at the time of sampling and an estimated moisture fluctuation zone of approximately 10 feet. Based on laboratory testing of specimens at in-situ moisture content, the maximum predicted **PVH is about 2 inches at existing grade**. Where footings exert continuous pressure, the swell potential beneath them will be reduced.

6.3.2 RISK ASSESSMENT

Risk and cost are inversely related and a decision must be made by the owner as to the best approach when weighing the risk of detrimental foundation soil movement against the cost of a foundation and floor system that either isolates the structure from such movements, or reduces the effect of such movements to a tolerable level. When expansive soils are present at a given site, the risk of soil movements detrimental to the building structure and function needs to be mitigated. A system utilizing a structural floor slab suspended above a void space and supported on deep foundations can virtually eliminate the risk, but is also relatively costly. Conversely, a floor slab placed on a prepared subgrade would likely be the least costly approach, but would also be more susceptible to damage from foundation soil movements, some of which are not accounted for in the



recommendations provided herein. Since the optimum approach is rarely immediately apparent, we provide the following information as an aid in dealing with the risk aspect of various approaches. Many factors must be considered in assessing the risk of shrink/swell behavior including:

1. Soil characteristics (Atterberg Limits, % fines - clay/silt)
2. Thickness of various soil layers and depth below the ground surface
3. Soil layer moisture content at time of construction relative to moisture content at time of testing and relative to the maximum attainable during swelling.
4. Restraint effect of overburden and/or foundation loads on heaving
5. Factors that contribute to change in soil moisture content including:
 - a. Rainfall
 - b. Drainage characteristics immediately adjacent to the structure
 - c. Desiccation effects of sun, wind and vegetation (such as trees and shrubs)
 - d. Seasonal depth of moisture penetration and exfiltration
 - e. Exposure to, or isolation from, drying or wetting effects both during construction and after completion
 - f. Landscaping and irrigation
 - g. Utility trench construction
 - h. Plumbing leaks

It is apparent that the actual movement experienced by a given portion of the structure is dependent on a complex interaction of the various factors noted above. The anticipated accuracy of predicted movement is determined by how well the prediction accounts for these factors. The TxDOT PVR method is widely accepted for prediction of shrink/swell movement potential, but is derived from empirical data and established correlations with Atterberg Limits. The USACE method, on the other hand, is based on measured swell of actual specimens and is, thus, considered superior to the PVR method in accounting for the soil heaving characteristics.

When we speak of foundation movements, we consider them as “potential” movements that may, in fact, only partially, or even never occur. The measures recommended in this report are intended to reduce the risk of exceedance of the predicted potential movements. It is the usual case that if these measures are properly implemented, structure performance is satisfactory. However, sometimes conditions outside the scope of this study (some of which are noted elsewhere herein) can result in excessive movement and structure distress.

Actual vertical change in soil thickness (i.e. heave or shrinkage) is directly related to the change in soil moisture content, so that if the moisture content change can be limited, the shrink/swell potential is reduced proportionally. However, moisture change is the hardest variable to assess and control. The perimeter areas of structures are typically the most susceptible to moisture change factors related to natural climate variations as well as the other factors listed in Item 5, above. The risk of moisture change for interior areas, however, is mainly related to Items 5e (during



construction), 5g and 5h.

The performance of floor slabs placed on native ground or prepared subgrade (i.e. undercut and replacement with select fill) is dependent on the accuracy of the shrink/swell predictions and our understanding of the finished grades. Because current prediction methods cannot precisely account for all the factors involved, as noted, the slab-on-grade option carries with it a greater degree of risk of distress than the structural floor option. The recommendations provided in this report will help to mitigate the risk, but will not eliminate it.

6.3.2.1 Recommended Approach

The choice of whether to go with a shallow or deep foundation system essentially depends on the owner's tolerance for risk and the comparison of the need for, and costs of, repair should damage occur vs. the additional construction costs of a relatively low risk system (i.e. deep foundation with a structural slab). We recommend that the foundations for the two structures consist of structural floors suspended above a void space on helical piles. Alternatively, a lower cost but higher risk approach could be considered consisting of shallow foundations monolithic with a slab on prepared subgrade where the footprint is undercut to remove a sufficient thickness of expansive clay to reduce the predicted PVR to 2" or less. In making these recommendations we considered the following:

1. Although the native clay soils beneath the structure locations in their current condition are quite moist with low to moderate swell potential, this condition could change if construction occurs following a prolonged dry period, thus increasing the swell potential.
2. The lake level tends to moderate moisture change in adjacent soils beneath that level.
3. Structures with wood cladding and/or which have no walls may tolerate more soil movement than those with brick or stone cladding.
4. The mature tree(s) near and/or within the footprint may have desiccated portions of the expansive clay beneath the proposed pavilion structure, although our testing did not confirm this hypothesis. In order to reduce the potential swell from rehydration of these pockets in the future, we believe that it is best to isolate the structure from the soil. If the slab is to be placed on grade, it is prudent to remove as much of the root zone of the trees as possible, but the extent of this zone could make this impractical.
5. Undercutting and replacement as recommended below, removes a portion of the potentially expansive soil from the zone of seasonal moisture fluctuation, but can also produce a "bathtub" that has the potential to collect water and induce deep-seated heave.
6. Undercutting to an elevation below lake level could encounter significant water seepage, depending on the local soil profile characteristics, potentially making earthwork operations difficult.
7. Under the normal circumstances cited above, the risk of undercutting and replacement would be mainly cosmetic cracking. Under abnormal circumstances (e.g. plumbing leaks, poor drainage, etc.), there is a risk of more significant impact.



8. Undercutting and replacement of expansive soil is normally the lowest cost approach in these circumstances, depending on the availability of select fill. However, the tradeoff of cost of undercutting and replacement of poor soil vs. the relatively low risk of a structural slab on helical piers approach needs to be evaluated by others.
9. If helical piles are selected for the support of one structure (e.g. restroom), the feasibility of their use on additional structures is increased.
10. Helical piles are not subject to uplift (as drilled concrete piers would be) due to the slenderness of their shafts. In cases where loads are anticipated to be much lighter than what a minimum drilled shaft could provide, helical piles, which are easily adaptable to light and heavy loads, would most likely prove more economical.

6.4 Predicted Soil Properties

6.4.1 DETERMINING REPRESENTATIVE PROPERTIES

Due to the non-homogeneous nature of soil and the necessarily limited data, the issue of assigning quantitative design parameters for the various characteristics of a soil mass is a matter of interpretation. In assessing shear strength along a failure surface that passes through a large mass, it is reasonable to expect that strength variations will be encountered along any potential surface. Where data are sufficient, we believe that it is overly conservative to take the lowest test data values as representative of the characteristics of a soil mass. On the other hand, using average values could be unconservative. How we recommend selecting appropriate values to use is explained below.

There is insufficient data (i.e. less than 30 data points for a given parameter for a given soil layer) to warrant a rigorous statistical analysis. Experience has also shown that the average (i.e. best fit to the scattered data) can be unconservative for soils that are not homogeneous (e.g. randomly variable degrees of sand content). We have adopted what we call a P_{25}/P_{75} approach (as originally promulgated by George Sowers) as an appropriate means for dealing with random variation in soil masses. The average of all applicable test results averaged with the lowest value is termed the "P₂₅" value. The average of all applicable test results with the highest applicable value is termed the "P₇₅" value. Rather than use the worst-case situation when sufficient data are available, we have used either the P_{25} value (when a low result would be conservative) or the P_{75} value (when a high result would be conservative) to predict parameters that are used to quantify the behavior of the soil mass. This procedure is only used when the variation in the data is anticipated to be spatially random. If there is a discernible pattern to the variation of the data (e.g. shear strength tends to be softer in low areas) then the data are grouped in accordance with the pattern prior to applying the method stated above (i.e. data are only averaged within groups).

Listed in the Table below are the soil strata with the predicted P_{25} and the P_{75} (as appropriate) properties selected to be applicable throughout the project. Note that properties in isolated situations may be adjusted more favorably when considering the specifics of the situation (contact E TTL for further information, if desired). These properties are derived from our testing of the soils



as well as our experience with the soils in question together with published correlations.

Table 6.4.1 Predicted Soil Engineering Properties							
Stratum No.	Moist / Buoyant Unit Wt. (pcf) ¹	Drained/Undrained Shear Strength Parameters ⁵		L-Pile Analysis Parameters ⁴		Settlement Parameters	Soil Class
		Φ	c (psf) ³	Soil Type	k (sand) / e ₅₀ (clay)	M _t ² (ksf)	
Select Fill (Sand)	115	32	0	Sand (Reese)	--	120	SC
Select Fill (Lean Clay)	125	0	2,000	Stiff Clay w/o Free Water (Reese)	0.017	120	CL
1	120 / 60	0	1,400	Stiff Clay w/o Free Water (Reese)	--	70	CH
2	120 / 60	0	2,000	Stiff Clay w/o Free Water (Reese)	--	150	CH

Notes:

- 1) Use buoyant unit weight indicated where applicable below groundwater table
- 2) Drained confined tangent modulus (ksf) derived from the stress strain curve of the consolidation test on indicated or similar soil, or E_s based on published correlations.
- 3) Peak Unconsolidated-Undrained shear strength (psf), measured by U.U. triaxial test on indicated or similar soils.
- 4) Use default L-Pile values for k and e₅₀ where not indicated otherwise
- 5) Peak drained (sands) and undrained (clays) strength parameters estimated from tests on similar soils and published correlations. Undrained strength see NOTE 3

6.5 Seismic Site Classification

IBC 2012/15 requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope does not include the required 100-foot soil profile. The current borings are a maximum of 25 feet below existing grade and the seismic site class recommendation assumes that the encountered material extends to a depth of 100 feet.

Based on the 2012/15 IBC, the seismic site class definition is **Class D "Stiff Soil"**. A summary report from the USGS Earthquake Hazards Program is located in Error! Reference source not found.. E TTL does not warranty the accuracy of this report and it is presented to the client for information purposes only.



For more information in regard to the program please visit:

<http://seismicmaps.org/>

7.0 GROUNDWATER

Seepage was measured as shallow as 8 feet and water level was measured at about 12 feet deep. Since there was insufficient time to allow for water level stabilization in the boring, the phreatic surface is likely higher than what was measured. We anticipate static groundwater level to be slightly higher than lake level. Excavations below groundwater level may encounter significant seepage

Data regarding groundwater level was generally obtained by observations in open boreholes. At best this provides only an approximation of the phreatic surface at the time of drilling (where readings are in open boreholes). *The phreatic surface that should be considered for the design of this project may vary significantly from that which was observed in the borings due to the following factors:*

- The characteristics of the soil profile may have prevented the water level in the boring from rising to the phreatic level during the time period of observation
- A given boring may not intercept groundwater bearing zones (i.e. the groundwater is perched or travels in seams or fissures that are not continuous over the entire site)
- Groundwater may only be perched in pockets above local aquacludes, but the distribution of borings is not generally adequate to confirm this with a high level of certainty
- Groundwater level varies seasonally and with rainfall
- Rotary wash drilling methods introduce fluid into the boring that often makes it impossible to distinguish between groundwater and drilling fluid

If the designer believes that the level of groundwater could significantly impact the project, then E TTL should be contacted to develop a plan for piezometer installation and monitoring to more accurately assess the groundwater levels at the site.

8.0 FOUNDATION RECOMMENDATIONS

Two independent design criteria must be satisfied in the selection of the type of foundation to support the proposed structure(s). First, the ultimate bearing capacity, reduced by an appropriate factor of safety (usually taken as 3 for DL plus sustained LL and which varies depending on the loading case) (or resistance factor if LRFD analysis), should not be exceeded by the bearing pressure



(factored for LRFD analysis) transferred to the foundation soils. Second, predicted total and differential vertical movements due to consolidation and/or expansion of the underlying soils during the operating life of the structure(s) should be within tolerable limits. Settlement limitations of isolated foundations, if any, were unknown at the time of report preparation. For most similar-type structures, 1 inch of predicted total settlement or heave is widely considered an acceptable target for design. *It should be noted, however, that if differential settlement or heaving of this magnitude were actually to occur, distress including cracks in walls, door frame distortion, etc. can be expected at least in some circumstances.* Where there are no walls supported on the floor (as for the pavilion), then additional potential could be considered as heaving of the floor may create some floor cracks, but there would be no partitions to be concerned about.

8.1 General Considerations

Moisture induced volume changes associated with the expansive clays present at this site indicate that shallow or near surface footings as well as floor slabs on existing grade or some thickness of select fill could be subject to differential movements of a potentially detrimental magnitude (beyond what is normally considered in the design process). A deep foundation system for the proposed structures penetrating to a depth below the zone of seasonal moisture fluctuation will substantially reduce the susceptibility of the foundations to shrink/swell movements and represents the least risk, but probably also the highest cost approach. As discussed in section 6.3, we recommend deep foundations (helical piers) for foundation support. Shallow spread footings on select fill would be a cheaper alternative and could be considered, but is subject to the additional risk factors noted. Pertinent design parameters and guideline considerations for both foundation system(s) are presented below.

8.2 Shallow Foundations

Recommendations are provided below for static loading only and do not consider the possible effect of vibrations, or impact loading, if any, and assume that shallow footings will be placed within the building footprint bearing in the recommended select fill. *These recommendations may not be suitable for footings placed externally in native soil.*

8.2.1 SHALLOW SPREAD FOOTINGS

Shallow footings (widths up to 8') can either be incorporated in a slab, or isolated from it. Footings should be designed to bear in properly compacted select fill at a minimum depth of 2 feet below the finished floor slab or immediately adjacent exterior grade (whichever is deeper). Isolated footings should have a minimum width of 2 feet and strip footings should be at least 12 inches wide. Footings should be proportioned for allowable gross concentric bearing pressures of 2,000 psf for individual (isolated) footings and 1,500 psf for continuous (strip) shallow footings. Eccentricity of load (if any) may decrease the above-recommended allowable bearing pressure significantly (contact this office for further guidance, if necessary). These allowable pressures incorporate a safety factor relative to shear failure of the soil of 3 or greater and may be increased up to 33% for intermittent loads such as wind or seismic.



8.2.2 SLIDING RESISTANCE FOR FOOTINGS ON GRADE

Ultimate sliding resistance provided by the soil embedment should be assessed by multiplying the minimum anticipated normal load on the base of the footing by a coefficient of 0.45 and adding passive resistance developed by the end face of the footing (if desired). The frictional component should be divided by a safety factor as deemed necessary.

Ultimate passive resistance of the soil loaded by a block should be computed by the following formula for both drained and undrained conditions and selecting the most critical condition:

$$P_p \text{ (drained)} = \gamma(K_p)z + 2c' (K_p)^{0.5}$$

$$P_p \text{ (undrained)} = \gamma(K_p)z + 2c (K_p)^{0.5} \text{ (usually reduces to: } \gamma z + 2c)$$

Where:

γ = effective unit weight

K_p = Passive pressure coefficient = $(\tan(45+\phi'/2))^2$ (generally equals 1 for undrained $\phi=0$ condition)

ϕ' = Effective angle of internal friction.

ϕ = Undrained angle of internal friction, generally = 0

c' , c (s_u) = drained/undrained cohesion

z = depth where pressure is determined

The appropriate parameters to be used in the above equation are to be selected from **TABLE 6.4** for the appropriate loading condition that controls (i.e. long-term(drained) or short term (undrained)) for the soil against the face of the footing. A significant amount of lateral movement is required to fully mobilize ultimate passive pressure (as much as 6% of the depth to the base of the loaded face). To limit the lateral movement to about 1% (of the depth to the base of the loaded face) a safety factor of about 2 to 2.5 is recommended for reduction of the passive component of resistance.

Full passive resistance assumes that the footing excavation can be constructed in such a manner as to provide solid contact of the side of the concrete with the undisturbed sides of the excavation (which may be impractical in some situations). *Caution:* Lateral resistance against a vertical face should only be assumed where construction can be controlled to assure that the footing is cast against undisturbed earth, or backfill between the excavation face (which needs to be constructed as nearly vertical as possible and extended to bottom of footing elevation) and the footing edge is placed under density-controlled conditions (backfill should be placed to 100% ASTM D698). It should be noted that such heavy compaction against a wall face will result in earth pressures against the wall exceeding the usually assumed active or at-rest pressures. *Also, the temporary excavation face needs to be nearly vertical and extended to the bottom of footing elevation. The portion of the sides of the excavation for the footing that is comprised of fat clay exposed to wetting or drying*



action and that is within 5' of the finished ground surface should be neglected with respect to computing passive resistance to account for possible softening or shrinkage of the zone.

8.2.2.1 Predicted Settlement

Settlement predictions are based on a subgrade prepared as recommended elsewhere herein. The predicted total settlement due to the maximum static vertical loads discussed above (not including transient loads) for generally square footings with maximum widths of 4' and for maximum sustained load of 1,500 psf is less than 1" total. Settlement is expected to vary roughly linearly with loading for given footing dimensions. Where eccentricity of load is anticipated, some rotation of the footing will be experienced, but it is generally predicted to be relatively small.

8.3 Deep Foundation Systems

Deep foundations may be used to support superstructure loads in addition to structural floor loads. We recommend helical piles

8.4 Helical Piles

Helical piles are a viable alternative to drilled shafts. Allowable capacities in compression up to about 50 kips are believed to be achievable for individual piles at this site (this needs to be confirmed by the pile vendor). Capacity in tension is generally approximately 70% - 80% of capacity in compression. The final design of all piles will be provided by the Helical Pile Specialty Engineer (HPSE) who will be the engineer of record for the helical piles.

8.4.1 HELICAL PILE SPECIFICATIONS

As recommended by the Helical Foundations and Tiebacks Committee of the Deep Foundation Institute (DFI) in their *Model Specification for Helical Pile Foundations Compression Applications*, provision of this type of deep foundation support system should be via a performance-based specification. Consequently, we recommend that the piles be designed, furnished and installed by a specialty design-build contractor. The DFI Spec covers all the bases related to design, testing and installation as well as field adjustments and verification of every pile placed on the job and is recommended for use with this project. We recommend the following information and amendments be incorporated into the DFI Spec:

1. Delete the recommendation that piles be evaluated and approved by ICC-ES in order to maximize the number of prospective bidders.
2. Piling should be designed by an engineer registered in the state of Texas, experienced in helical pile design.
3. Capacity should be checked for both long-term (drained) and short-term (undrained) loading conditions. Adjustments to standard interpretation of load tests may be necessary, depending on which load case controls the design.
4. The top helix should be placed a minimum of 15 feet below existing grade.



5. Maximum spacing between piles of 3 times the diameter of the largest helix at the depth of the helix, not necessarily at the pile head.
6. The recommended minimum factor of safety is 2.0 assuming that each pile will be evaluated based on a correlation of final installation torque to load capacity. For critical structures a higher safety factor may be appropriate.
7. Maximum tolerable axial deformation (elastic shortening plus settlement) of individual piles needs to be specified in keeping with characteristics of the structure to be supported.
8. Corrosion service life needs to be specified (usually 50 years per most building codes (75 years for transportation and critical structures)). It is almost always the case that soil bearing capacity is the controlling factor in the pile design. The size and thickness of the steel pile shaft is controlled by the torque necessary for installation, which usually produces a section much thicker than what is needed to transfer load to the helix. As a result, potential thickness loss of the steel pile shaft due to corrosion (even where the pile is not treated for corrosion resistance) usually has a relatively minor impact on capacity during a typical design life.
9. The potential number of piles does not warrant specific static verification load testing of each pile type to develop a correlation between installation torque and proven static load capacity.

8.5 Grade Beams and Load-Bearing Elements used with Deep Foundations

All grade beams and load-bearing elements (columns and load-bearing walls) should be supported by the deep foundation elements. A minimum **8-inch void space** should be provided beneath all grade beams to prevent contact with the swelling clay soils. This void will serve to reduce distress resulting from swell pressures generated by the expanding clays. Sides of grade beams should be formed rather than cast against soil.

Where a void is recommended, grade beams may be cast on cardboard carton forms or formed above grade. If cardboard carton forms are used, care should be taken to not crush the carton forms, or to allow the carton forms to become wet or otherwise degraded prior to or during concrete placement operations. A durable soil retainer should be provided to help prevent in-filling of this void when the carton form decays.

Backfill around the structure perimeter and against the exterior face of grade beams or panels should be properly compacted native clays a minimum of 5' wide and 1.5' thick with a top surface sloped at a minimum of 5% for a distance of 10' from the structure. Compaction should be to a minimum of 95 percent of ASTM D 698, at optimum moisture content or above as determined by that test. This clay fill is intended to reduce surface water infiltration beneath the structure. Loosely placed backfill will facilitate infiltration of surface drainage and could lead to excessive differential heave.



9.0 FLOOR SYSTEMS AND FLATWORK

Structure floor systems placed on native subgrade will be subject to differential movements and other issues as noted in **Section 6.3**. In order to reduce the potential movements to about 1" - 2" we recommend that the building subgrade be prepared as recommended in **Section 10**. Even with replacement of the expansive subgrade with non-expansive fill the risk of heaving and shrinkage, though reduced, is not eliminated. Overexcavation and replacement of a portion of the expansive clay with more permeable select fill to reduce the potential movement can, in some instances, create a "bathtub" (reservoir) beneath the structure that has the potential to collect surface drainage (or water from other sources such as plumbing leaks) at its base. Water that collects on the native clay at the base of the undercut will soak into the deeper, expansive clays over time thus increasing the risk of excessive deep-seated heave.

If the risks from predicted potential vertical differential movements as noted in **Section 6.3** and as modified per the provisions of **Section 10** of this report cannot be tolerated, a structurally suspended floor slab should be used to significantly reduce the risk of distress.

9.1 Structurally Suspended Slab

The most positive means of eliminating the effects of vertical subgrade movements on the structure is to structurally suspend the entire floor system (including grade beams) as well as all other non-load bearing elements between drilled piers and above the ground. This may be accomplished via the use of **8-inch thick void forms** (placed in accordance with manufacturer's recommendations) upon which a structurally reinforced concrete slab is placed, or may take the form of a structurally framed floor system above a crawl space. Any appurtenances attached to the structure such as entrances, stairs or decks should also be suspended above an **8-inch thick** void space and supported on piers. Permanent soil retainers at the edges of voids are recommended to prevent soil from migrating into the void space when the void forms deteriorate.

Care should be taken to assure that the void boxes are not allowed to become wet or crushed prior to or during concrete placement and finishing operations. As a quality control measure during construction, "actual" concrete quantities placed should be checked against "anticipated" quantities. Significant concrete "overage" would be an early indication of a collapsed void, which should be remedied by replacing the collapsed form. The floor system should also be designed to resist the crushing pressure of the void boxes in the event that soils expand prior to deterioration of the void boxes.

9.1.1 DRAINAGE OF VOID SPACE

A perimeter drainage system should be provided to intercept and prevent the collection of surface drainage (as well as other potential sources of water) in the void spaces beneath the structure. Landscape irrigation water and/or rainfall running down the face of a structure can infiltrate the ground surrounding the structure (where there is no abutting moisture barrier such as a pavement



sealed to the edge of the structure), collecting in the void beneath the perimeter beam and floor slab, possibly leading to excessive heave or other moisture-related problems (e.g. rupture of plumbing connections). This drain system should be similar to that recommended in UFC 3-220-07 *FOUNDATIONS IN EXPANSIVE SOILS*, Section 7.2.b.

9.1.2 CRAWL SPACE

If a crawl space is utilized, provision should be made to provide drainage of the crawl space below the slab, in the event water enters into this area. The void space created beneath the floor system should be sealed so that it does not collect surface drainage. The base of the space should be higher than the surrounding ground to reduce the chances that water will collect in it. Where this is not possible, provisions of section 9.1.1 are recommended.

9.2 Slab on Grade

As an alternative to a structural slab, floor slabs (and exterior flatwork, if desired – See Section 9.4) can be placed on a subgrade prepared as described in Section 10. Slab-on-grade construction should only be considered if slab movement (and potential consequent damage) as noted throughout this report can be tolerated. The level of acceptable movement varies with the design and other requirements, but methods are normally selected with the goal of limiting predicted slab movements to about 1 - 2 inches or less. Reductions in anticipated movements can be achieved by using subgrade modification methods developed for that purpose. The more commonly used method consists of undercutting and replacing the expansive soils. The use of this method will reduce, *but not eliminate* the risk of unacceptable movements.

9.3 Building Perimeter Area

Backfill around the structure perimeter and against the exterior face of grade beams or panels should be properly compacted native clays a minimum of 8' wide and 1.5' thick where the subgrade is not otherwise protected from moisture change by abutting pavement. Compaction should be to a minimum of 93 percent of ASTM D 698, at optimum moisture content or above as determined by that test. This clay fill is intended to reduce surface water infiltration through the select fill beneath the structure. Loosely placed backfill will facilitate infiltration of surface drainage and could lead to excessive differential heave.

Planting beds adjacent to the structure should be contained in leak proof boxes or a horizontal moisture barrier sealed to the grade beam should be used in conjunction with them in order to isolate the building subgrade from water infiltration sources such as sprinkler systems.

Isolated vehicle or pedestrian ramps that are not part of a larger pavement surface leading up to the building should be configured to avoid abrupt differential movement between the building slab and the ramps which could occur where such elements are supported on the native subgrade while the building is supported on deep foundations and/or where a portion of the native soil beneath the building has been replaced with non-expansive fill. Transitioning details will be required at the



points where ramps connect with paving and other slab on-grade elements. In addition, ramp slabs should be constructed so that slopes sufficient for effective drainage of surface water are still provided after the potential differential movements discussed elsewhere herein have occurred.

Where the predicted potential differential heave between elements supported on native subgrade and the structure which is constructed on prepared subgrade is considered significant (as discussed in **Section 6.3**), “hinge” slabs that are doweled into the structure grade beam (or otherwise supported on it) and designed to span over a void below to native grade at some distance from the building, allow the exterior slab to rotate about its joint with the grade beam without significant distress. Such hinge slabs also help to prevent moisture fluctuation in the perimeter zone of the structure where an effective seal is maintained at the joint. Such slabs should be sloped sufficiently to prevent an eventual slope toward the building resulting from exterior subgrade heave.

9.4 Exterior Flatwork (Sidewalks, Patios, Etc.)

Flatwork placed on grade will be subject to movement due to subgrade swelling or shrinkage, the amount of which depends on the preparation of the subgrade (see **Sections 6.3 and 10**). The movement is usually most pronounced in the immediate vicinity of exposed edges of the slabs and is generally much less in the interior areas, provided that the surface is well maintained with joints and cracks sealed. Conditions at the edges of slabs on grade should be sufficient to provide for rapid drainage of surface water away from the edge. Shrubs, trees and planting beds in the vicinity of pavement edges are often causes of excessive fluctuation of soil moisture leading to distress of adjacent flatwork.

Consideration should be given to extending the subgrade preparation to include entrances, sidewalks, porticos, flatwork or any other areas sensitive to movement and where the predicted potential movement is considered significant. Outside the zone of prepared subgrade for the building (i.e. outside an area including 5’ outside of the building line (including entrance porch)), a minimum cover of 12 inches of select fill can be used to reduce the potential movement somewhat.

In order to reduce abrupt differential movements between exterior flatwork areas that are placed on prepared subgrade and those that are not where predicted potential movements are significant, consideration should be given to a transition zone whereby the depth of treatment is tapered from the full depth zone up to the ground surface at a slope of 1:1.

Although movement potential can be reduced by the removal, or moisture treatment of problematic soils, it may be more economical to maintain and repair the flatwork rather than to extensively remove or treat potentially expansive soil. Determining the optimum approach was beyond the scope of this investigation.

Irrigated landscaped areas often surround exterior flatwork areas. Moisture fluctuations in the landscaped areas surrounding relatively narrow flatwork areas can subject the soils underlying the



flatwork to expansion and contraction. In order to reduce the risk of moisture fluctuations in the upper portions of the soil profile beneath the slab, consideration can be given to a vertical moisture barrier along the perimeter of the flatwork.

Sidewalks should not be placed in a manner that could impound water adjacent to the structure should they be subject to heave (predictions of the degree of potential heave are discussed in **Section 6.3**) at some time in the future. Articulating joints in the flatwork can serve to lessen the extent of distress due to shrink/swell movements of the soil upon which they are placed. Such joints will require regular maintenance to maintain a sealed condition. The better the drainage and joint and crack maintenance, the lower the risk potential for distress.

10.0 EXCAVATION AND BACKFILL OPERATIONS

10.1 Building Footprint Subgrade Preparation

In order to validate the design assumptions given above regarding allowable foundation loads, and, in order to provide a serviceable floor system (within the limitations stated above), it is imperative that the subgrade of the building be properly prepared. The following procedures are recommended as a minimum:

- Remove any surficial vegetation, organic material, topsoil, soft clay, utilities and pavement. Loose or granular backfill in utility trenches can sometimes be conduits for water which could result in moisture change of soils and consequent heaving. As a minimum, provide a clay plug in the utility trench at the building perimeter for the purpose of precluding water transmission through the trench beneath the building.
- Where trees are removed (or have been removed within the last several years) from the footprint, the entire root zone should be cut out and replaced with select fill. Root zones tend to be comprised of highly desiccated soil, which, if left in place, are prone to significant swelling later on, resulting in heaving of the slab. Clean all excavations of disturbed or loose soil and debris. Verify that all stump holes are backfilled with properly compacted select fill.
- The following *minimum* overexcavation below finished exterior grade is recommended. Limits of overexcavation should extend beyond building and/or footing lines a distance of 5'. Transition between different undercut depths as well as between undercut areas and finished grade using a 1:1 slope.
 - *Slab on grade building floor systems* – Overexcavate native subgrade to a depth of 4 feet to reduce the predicted PVR to 2", or overexcavate to a depth of 7 feet to reduce predicted PVR to 1". Note that excavation below an elevation slightly



above lake level may encounter groundwater seepage requiring some additional measures to manage the seepage during fill placement.

- Scarify the exposed subgrade to a depth of 8 inches, adjust the moisture content to, and maintain it within a range of optimum to optimum +4% and recompact to a minimum density of 95% of the maximum density defined by ASTM D 698 (Standard Proctor). *Maintain specified moisture content until subgrade is covered with fill or concrete.*
- Place select fill to finished slab subgrade. Specifications for the placement of select fill are covered in **Section 10.3**. Maintain finished subgrade in a moist condition until covered with slab.

10.2 Footing Subgrade Excavation and Preparation

Footing excavations should be constructed utilizing smooth edged bucket excavators to provide a bearing surface that is free of grooved zones and is comprised entirely of undisturbed native ground. A mud slab may also be desirable to prevent degradation during construction of what may be a saturated foundation surface (as applicable). The base of the structure excavation should be graded to drain water off of the structure footprint at all times.

Rough grade surrounding the structure excavation should preclude drainage into the excavation while it is open. Finished subgrade in the vicinity of the structures should be shaped to preclude standing water and to provide for rapid drainage of surface water away from all structures to help limit the potential for surface water infiltration and consequent foundation movement.

10.3 Select Fill Beneath Structures

Select fill shall consist of homogeneous soils (i.e. not sand with clay lumps) free of organic matter and rocks larger than 6 inches in diameter and possessing an Atterberg plasticity index (PI) of 8 to 18, with a liquid limit of 40 or less and a percent passing the #200 sieve between 30 and 75. Permeability should not exceed 1×10^{-5} cm/sec at in-place density (testing to confirm is recommended). Atterberg limits testing of the fill at a rate of 1 test per 500 cubic yards of fill placed (minimum 1 test per fill area and as visual changes occur) is recommended to verify that fill specifications are met. The material should be placed in the following manner:

- Prepare the subgrade in accordance with the recommendations discussed elsewhere herein. Sites that slope more than about 15% should be benched with 5-foot wide benches prior to placing fill.
- Place subsequent lifts of select fill in thin, loose layers not exceeding 9 inches in thickness to the desired rough grade, compacting each lift to a minimum of 98% of the maximum



density defined by ASTM D 698 (Standard Proctor). Maintain moisture within a range of optimum to optimum +4%.

- Conduct in-place field density tests at a rate of one test per 3,000 square feet in the structure areas (every 5,000 square feet in the parking area) for every lift with a minimum of 2 tests per lift. *Density testing is essential to assure that the soil, which supports the structure, is properly placed.*
- Prevent excessive loss of moisture during construction.

10.3.1 ON-SITE SOURCE

None of the spoils that may be generated by earthwork operations will qualify as select fill.

10.4 Common Fill

Common fill may consist of any of the following soil classifications: SC, CL, CH and may be used as fill to bring the site to grade in areas where other specific preparation is not desired and where differential soil movement is not critical. Proper processing, placement and testing of this material is essential. Sandy soils that classify as silty sand (SM) or poorly graded sand (SP) or well graded sand (SW) should not be used as fill as they will likely become reservoirs for water in the future. Listed below are several factors that must be considered if fat clay (CH) is to be used for fill:

- The material must be uniform (homogeneous). It cannot be blocky or shaley or a mixture of various types of soils or even various types of clays.
- The clay must be processed to assure uniform moisture distribution (a good rule of thumb for gradation is 1" or less). Discing of the clay may not be adequate for this process. Sometimes the use of a pulvermixer is necessary. Processing and watering the clay in place prior to picking it up and moving it is typically more effective since it allows more time for the water to penetrate the soil "clods." Some shaley clays cannot be effectively processed.

Place processed soil in loose lifts not exceeding 9" in thickness and compact to a density of 95% to 98% of ASTM D698 (Standard Proctor) and maintain moisture at optimum to optimum +3% or above. The fill must not be allowed to dry prior to placement of succeeding lifts.

10.5 Constructed Slopes

Cut and fill slopes are typically stable when constructed no steeper than 3:1. Slopes taller than about 10 feet may require additional analysis to predict stability.

10.6 Excavation Safety

The Federal Register, Volume 54, No. 209 (Latest Revision), the United States Department of Labor, Occupational Safety and Health Administration (OSHA) contain the "Construction Standards for



Excavations, 29 CFR, part 1926, Subpart P". The contractor is solely responsible for designing and constructing stable, temporary excavations in accord with these standards and should shore, slope or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in CFR Part 1926, should evaluate the soil exposed in the excavation as part of the contractor's safety procedure. In no case should the height, slope inclination, or excavation depth, including utility trench excavation depth, exceed those specified in local, state, and federal safety regulations. Testing to evaluate the stability for the soils during excavations at this site was beyond the scope of this study.

11.0 GENERAL CONSTRUCTION CONSIDERATIONS

11.1 Site Design

The following recommendations are derived from years of experience with structures founded on expansive soils and are considered essential to satisfactory structure performance:

- Sidewalks should be sloped away from buildings. The joint between the sidewalk and the foundation should be sealed. Sidewalks should not impound water adjacent to the structure. Potential heave of native ground (see Section 6.3) adjacent to the structure needs to be taken into consideration when constructing the walk so as to avoid a sidewalk which impounds water adjacent to the structure.
- The ground surface around the building as well as paved areas should be sloped away from the building or pavement edge on all sides so that water will rapidly drain away from the structure. A minimum slope of 5% is recommended for the area 10 feet wide immediately adjacent to the structure. Roof drainage should be conveyed by an appropriate means for a distance of at least 15 feet from the building before it is allowed to drain into the subgrade. Water should not be allowed to pond near the building after the floor system has been placed.
- Trees should not be closer than their mature height to the structure and shrubbery should not be planted adjacent to the building unless they can be contained in watertight planter boxes and irrigation water can be prevented from seeping into the subgrade around the building. A horizontal moisture barrier (e.g. polyethylene (Stego Wrap or similar) permanently sealed to the foundation edge at the ground line and sloped away from the building) and placed beneath planting beds is an alternative to planter boxes provided it is maintained in a watertight condition (i.e., joints sealed and punctures promptly repaired). Planting bed edging should not impound water. A root barrier around the entire structure perimeter will provide some added assurance against desiccation of the soil due to roots growing beneath the structure. Periodic root pruning may be required to limit drying of soils beneath foundations due to vegetation. *Over irrigation adjacent to the structure can cause an increase in subsurface moisture contents that could lead to heaving.*



- To help limit surface water infiltration beneath the structure, backfill in the area 10 feet wide adjacent to the structure should be native lean or fat clay soil compacted to a minimum density of 95% of ASTM D 698 (Standard Proctor) at a moisture content of optimum or above. This zone should be at least 2 feet thick. This backfill is not necessary where pavement abuts the structure and the joint is sealed. For optional additional risk reduction (for grade-supported elements), a vertical moisture barrier sealed to the side of the foundation and extending to a depth of about 8' will provide added protection against moisture fluctuation beneath the building footprint.
- Backfill for new utility line ditches and ditches where old lines have been removed should be carefully controlled and should consist of a relatively impermeable material (clayey sand (SC) or lean clay (CL) as specified for select fill), especially in the area beneath and immediately outside of the structure. Granular fill (or loose backfill) that is often used to embed utility lines can become a conduit to feed free water under the structure resulting in heave, and, so, should not be used. Old utility lines should be removed from beneath the structure. Fill in new and old utility trenches should be placed to the same specifications as select fill. The top 6 inches under paving should be compacted to a density equal to that specified for the pavement subgrade.
- Utility connections to the building should be flexible to allow for anticipated soil movements (see predictions of magnitude elsewhere in this report) that will be different than the anticipated movement of the structure to which they are connected (e.g. where a suspended slab on piers is used). Drain lines should be placed so that potential movements the building vicinity do not affect functionality of the line.
 - The significant differential movement potential between structures supported on deep foundations and the native subgrade needs to be addressed in the design of utilities (See **Section 6.3** for predicted soil movements) in order to accommodate excess differential movement that cannot be accommodated by specialized utility connections at the structure. Common approaches to this issue entail utility conduits isolated from subgrade movements via voids and support on deep foundations and/or utility corridors placed on prepared subgrade. Removal of about 4' below existing grade will reduce the predicted movement potential to about 2" for utilities placed within the backfill of such a trench. There will need to be a transition zone where the depth of soil preparation within the corridor tapers from full depth to none at a 1:1 slope. Verify that the consequent slope (i.e. 2" over a distance of 4') of the utilities can tolerate this differential slope and still be functional. The prepared zones beneath utility corridors should be twice the width of the corridor at its base tapering up to the ground surface at a 1:1 slope in all directions (i.e. perpendicular to the longitudinal axis of the corridor).



12.0 PAVEMENT RECOMMENDATIONS

The following are general recommendations for the construction of *typical minimum* pavement sections. Whether these minimum sections will prove suitable for the traffic that will access them is unknown as the characteristics of such traffic are unknown. To better assess the adequacy of a given design, a more detailed pavement analysis is needed. This would at least require details regarding projected traffic patterns (vehicle type and frequency of travel over a given area) and possibly additional laboratory tests on bulk samples of the materials to be used in pavement construction. This analysis is beyond the scope of the current investigation, but can be provided later, if desired.

These recommendations are based on surface soil characteristics inferred from the borings drilled for the buildings and pavement areas. An inspection of the pavement subgrade after it is cut to finished grade should be made to determine the applicability of these recommendations. Both flexible and rigid pavement sections are presented. A summary of proposed designs is provided in **Tables 12.1 and 12.2** below.

12.1 Pavement Subgrade Preparation

As a minimum, strip the native subgrade to remove topsoil, thin (18" or less) silty sand layers above clayey soils and other deleterious materials, including debris-contaminated soils. Tree root zones often contain highly desiccated soil that, when left in place, often eventually results in heaving after a period of rewetting. The only way to limit this potential is to remove these zones and replace them with select fill. Verify that all stump holes as well as areas disturbed by demolition activity, if any, are cut out and backfilled with properly compacted select fill. The heaving effect can be reduced with good pavement drainage and maintenance. If this is not feasible, then future additional pavement maintenance will probably be necessary.

Cut to the proposed subgrade elevation as required. Exposed subgrade should be proof rolled prior to compaction or treatment in accordance with TxDOT Item 216 with the exception of roller size. The use of a fully loaded dump truck is recommended. Areas, which prove unstable should be cut out and replaced with select fill. In areas that are below finished subgrade elevation or which are to be lime treated, scarify the exposed subgrade to a depth of 8 inches, adjust the moisture content to within a range of optimum to optimum $\pm 3\%$, and recompact to a minimum of 98% of the density as defined by ASTM D 698 (Standard Proctor). Lime treatment of subgrade that consists of native clay, or native clay fill with a PI >18 is recommended as set forth below. Positive surface drainage should be maintained during all phases of construction (especially in low areas) to help keep pavement subgrade in a dry and stable condition.



12.1.1 UNSUITABLE SUBGRADE SOIL

Where the exposed finished subgrade is found to consist of soil with a $PI > 18$, cut out the plastic clay to an elevation equal to finished subgrade minus 18", or deeper if necessary, to expose stable ground (as determined by proof rolling as specified below). Scarify the exposed soil to a depth of 8", adjust the moisture content to within a range of optimum to optimum +3% and recompact to a minimum density of 98% of ASTM D698 (standard proctor). Alternatively, plastic clays can be left in place and stabilized with lime as recommended hereinafter.

12.1.2 SUITABLE SUBGRADE SOIL

Where native soil exposed at finished subgrade elevation consists of a soil with a $PI \leq 18$ and classifies as SM (except as noted elsewhere herein), SC or CL (note that silty sand (SM) soils are not suitable for finished subgrade of full depth HMAC pavement surfaces), it should be proof rolled in accordance with TxDOT Item 216 (with the exception of roller size). The use of a fully loaded dump truck is recommended. Areas, which prove unstable should be cut out and replaced as directed by a representative of this firm. Scarify the exposed soil to a depth of 8", adjust the moisture content to within a range of optimum +/-3% and recompact to a minimum density of 98% of ASTM D698 (standard proctor).

12.1.3 FILL CONSTRUCTION

Fill to be placed which is below an elevation of finished subgrade minus 18" may consist of any soil and should be compacted to a minimum density of 95% ASTM D698 (standard proctor) at a moisture content within the range of optimum $\pm 3\%$ except for fat clay soils which should be placed at above optimum moisture contents. Lime treatment of the finished subgrade can be omitted where the top 18" of finished subgrade in fill areas consists of a select material classifying as SC or CL and with the following properties: a PI ranging from 8 to 18, a liquid limit ≤ 40 and a percentage passing the #200 sieve $> 30\%$ and $< 70\%$ (note that silty sand (SM) soils are not suitable as finished subgrade for full depth HMAC pavement surfaces). It should be noted these recommendations for select fill material vary from those for the structure fill.

12.1.4 SPECIAL REQUIREMENTS

Islands and irrigated areas adjacent to pavement edges can be a source of pavement problems. Over watering can lead to infiltration (and consequent destabilization) of flexible base material and/or subgrade adjacent to the area. Where a flexible pavement option is chosen, areas subject to over watering (especially sprinklered islands) should be designed to contain all irrigation water (i.e. prevent leakage out the bottom into adjacent stone base material). An alternate, but less desirable, solution is to place a strip of base material in the immediate vicinity of the potential infiltration to replace the full depth of the crushed stone base and comprised of HMAC base rather than crushed stone.

Where trees or shrubbery will be planted or will remain in close proximity to the pavement edge, or where the pavement edge is subject to extreme drying action, deep drying of the subgrade beneath the pavement edge (within root zones of vegetation where present) can lead to cracking of the



subgrade and pavement in the vicinity of the edge. The only effective ways to prevent this sort of distress are to undercut the active clay subgrade and replace it with select fill, or prevent drying of the subgrade through the use of moisture/root barriers.

Use of a geogrid (Tensar TX5 – no recommended substitute) between the crushed stone base and the subgrade can limit propagation of cracks from the subgrade up into and through the base and surface. *We recommend that TX5 be specified regardless of lime treatment, especially where there is a shoulder width of 6' or less provided.* Additional details regarding these measures will be provided upon request.

12.1.5 LIME TREATED SUBGRADE

Lime treatment of subgrade should be in accordance with Item 260, "Lime Treatment for Materials Used as Subgrade (Road Mixed)," Texas Department of Transportation *Standard Specifications for Construction of Highways, Streets and Bridges*, 2014 Edition with the following exceptions:

- Under article 260.4 (4), "Application," the rate of lime to be applied can be estimated as 40 pounds per square yard worked into the top 8 inches of finished subgrade. *The actual amount of lime to be used should be based on tests of lime soil mixtures conducted prior to treatment.* Quicklime, if used, must be hydrated before mixing into the soil.
- The modified subgrade should be compacted under article 260.4 (6) (b), "Density Control," except that it shall be compacted to 98% of Standard Proctor Density (ASTM D698) *at a moisture content well above optimum* to allow for the drying action of the lime.
- Curing procedures should be strictly followed. Traffic on the treated subgrade should be kept to a minimum during curing.
- Prior to use by significant traffic, the treated subgrade should be covered with base, concrete or some temporary wearing surface to avoid degradation.

12.1.5.1 Sulfate Testing of Lime Treated Subgrade

It is possible that native clays contain a sufficient quantity of soluble sulfates that can adversely react with hydrated lime. Testing for soluble sulfates was outside the scope of this project. Soils that contain a sufficient quantity of soluble sulfates can cause an adverse reaction when stabilized with hydrated lime or cement. This would lead to sulfate induced heave if lime (or cement) stabilization were to be used. Typically, the possibility of sulfate induced heave is when sulfate contents are above 3,000 mg/kg. However, at sulfate contents less than 8,000 mg/kg, lime stabilization is still feasible as long as the moisture content is mixed above optimum. If lime stabilization is used, TxDOT recommendations should be strictly followed. Sulfates generally occur in veins that may or may not be intercepted by the procedures used to obtain samples for this



study. Once the site is cut to grade, the exposed subgrade should be inspected by a qualified technician and samples obtained for sulfate testing per Tex 145E.

12.1.5.2 Alternatives to Lime Treatment

For the flexible pavement option (only) placing a geogrid (Tensor TX5, no substitute) on the prepared native subgrade prior to placing base material will serve as a substitute for lime treatment of the subgrade (except as recommended otherwise elsewhere herein). For the full depth HMAC section, lime treatment of the subgrade may be omitted if the thickness of pavement surface specified is increased by 1". For the rigid pavement option (concrete) increase the recommended thickness by 0.5" where lime treatment is omitted.

12.1.6 STABILITY OF FINISHED SUBGRADE

The stability of the finished subgrade should be verified by proof rolling (as specified above) prior to placing base material or surfacing. Unstable areas will need to be cut out and reworked.

12.2 Light-Duty Pavements

12.2.1 FLEXIBLE PAVEMENT

The minimum pavement section (and a section commonly used) for light-duty driveways and parking areas consists of 6 inches of crushed stone base with 2 inches of hot mix asphaltic concrete (HMAC). Crushed stone base should comply with Type A, Grade 1/2, Item 247 of the *Texas Department of Transportation (TxDOT) 2014 Standard Specifications for Construction of Highways, Streets and Bridges*. Compaction of the stone base should be to a minimum of 95 percent of ASTM D 1557 (modified proctor) maximum density at optimum moisture ± 3 percent. Asphaltic concrete surfacing should comply with the requirements of Type D, Item 340 of the TxDOT Specifications and should be compacted to a density of 92 to 94 percent of maximum theoretical density.

12.2.2 FULL DEPTH ASPHALT

The **minimum** full depth asphalt pavement section consists of 3 inches of hot mixed asphaltic concrete binder course (Type B) with 2 inches of hot mixed asphaltic concrete surfacing (Type D). Asphaltic concrete surfacing should comply with the requirements of Type D, Item 340 of the TxDOT Specifications and the asphaltic concrete binder should comply with the requirements of Type B, Item 340. All HMAC should be compacted to a density of 92 to 94 percent of maximum theoretical density.

NOTE: Not recommended for subgrades comprised of silty sand (SM) due to potential installation difficulties in parking areas.

12.2.3 RIGID PAVEMENT

The performance of concrete pavement is dependent on many factors including weight and frequency of traffic, subgrade conditions, concrete quality (which itself is dependent on a host of factors), joint type and layout, jointing procedures, and numerous construction practices. A



detailed discussion of all of these items is beyond the scope of this report. By way of general guidance, the following recommendations are offered:

- Minimum concrete compressive strength of 3,500 psi at 28 days. The water/cement ratio should be 0.45 or less. The mix should contain 4% - 6% entrained air for durability.
- Minimum pavement thickness of 5 inches.
- Adequate site drainage to prevent ponding on or near the pavement.
- Allow a minimum of 7 days curing time before permitting traffic on the pavement.

The designer is referred to the following website for more detailed information:

<https://www.pavementdesigner.org/>

12.3 Medium-Duty Pavements

12.3.1 FLEXIBLE PAVEMENT

For areas that will be subject to trash or delivery truck parking and traffic, the minimum recommended flexible pavement section consists of 8 inches of crushed stone base and 3 inches of asphaltic concrete surfacing. The 3 inches of surfacing may be composed of fine-graded surface course (Type D) or coarse-graded surface course (Type C). Paving materials should be specified as discussed previously.

12.3.2 FULL DEPTH ASPHALT

For a medium-duty full depth asphalt section, the minimum recommended section is 6 inches of HMAC paving consisting of 2 inches wearing surfacing (Type D) over 4 inches of asphaltic binder (Type B). Paving materials should be specified as discussed previously.

NOTE: Not recommended for subgrades comprised of silty sand (SM) due to potential installation difficulties in parking areas.

12.3.3 RIGID PAVEMENT

Recommendations for medium-duty concrete paving are the same as for light duty except that 6 inches of Portland cement concrete should be considered the minimum pavement section .

12.4 Heavy-Duty Pavements

12.4.1 FLEXIBLE PAVEMENT

For areas that will be subject to heavy truck parking and traffic, the *minimum recommended* flexible pavement section consists of 7 inches of crushed stone base and 4.5 inches of asphaltic concrete



surfacing. The 4.5 inches of surfacing may be composed of 2 inches of fine-graded surface course (Type D) wearing surfacing overlying 2.5 inches of coarse-graded surface course (Type C). Paving materials should be specified as discussed previously.

12.4.2 FULL DEPTH PAVEMENT

For a heavy-duty full depth asphalt section, the minimum recommended section is 7.5 inches of HMAC paving consisting of 2 inches of hot mixed asphaltic concrete surfacing (Type C or D) over 5.5 inches of asphaltic concrete base course (Type A or B). Paving materials should be specified as discussed previously.

NOTE: Not recommended for subgrades comprised of silty sand (SM), or poorly graded sand (SP-SM) due to potential installation difficulties in parking areas.

12.4.3 RIGID PAVEMENT

Recommendations for heavy duty concrete paving are the same as for light duty except that 7 inches of portland cement concrete should be the minimum pavement section.

Table 12.1 - Pavement Options – Light Duty			
Type	Base/Surface Thickness		Subgrade Preparation
Flexible HMAC	2" Surface ⁹ (Type D)	6" Crushed Stone Base ⁸	Notes 1 to 4
Full Depth HMAC ⁵	2" HMAC Surface ¹⁰ (Type D)	3" HMAC Base (Type A or B)	Notes 1 to 4
Concrete	5" ¹¹	No Base Recommended ⁶	Notes 1 to 4

Table 12.2 - Pavement Options – Medium Duty			
Type	Base/Surface Thickness		Subgrade Preparation
Flexible HMAC	3" Surface ⁹ (Type C or D)	8" Crushed Stone Base ⁸	Notes 1 to 4
Full Depth HMAC ⁵	2" Surface ¹⁰ (Type C or D)	4" HMAC Base (Type A or B)	Notes 1 to 4
Concrete	6" ¹¹	No Base Recommended ⁶	Notes 1 to 4



Table 12.3 - Pavement Options – Heavy Duty			
Type	Base/Surface Thickness		Subgrade Preparation
Flexible HMAC	2" Surface ⁹ (Type C or D)	2.5" HMAC Base & 7" Crushed Stone Base ⁸	Notes 1 to 4
Full Depth HMAC ⁵	2" Surface ¹⁰ (Type C or D)	5.5" HMAC Base (Type A or B)	Notes 1 to 4
Concrete	7" ¹¹	No Base Recommended ⁶	Notes 1 to 4

Notes:

- 1) Cut out and remove all topsoil, organics and debris-contaminated soil. Cut to grade if required.
- 2) A visual inspection and proof roll of the exposed subgrade shall be made to determine areas to be undercut and replaced with select fill.
- 3) Treat subgrade with lime and compact to a minimum density of 98% of ASTM D698 (Standard Proctor).
- 4) Stability of the finished subgrade should be verified by proof rolling in accordance with TxDOT.
- 5) Not recommended for subgrades comprised of silty sand (SM), or poorly graded sand (SP-SM) due to potential installation difficulties for parking areas.
- 6) Where finished subgrade is sand (SP, SM, SP-SM, SC-SM), 4 inches of compacted Flex Base or 6" of cement stabilized subgrade will increase longevity by providing a non-erodible base. Especially desirable where pavement is also on a significant slope and/or where subject to heavier trucks.
- 7) Entry, exit and trash receptacle areas should be in accordance with concrete heavy-duty design, or per local city or county standards.
- 8) Tensar TX5 Geogrid placed on subgrade beneath base is recommended to help control longitudinal cracking, especially where the pavement shoulder is 6' or less, and may be substituted for lime treatment of subgrade.
- 9) Increase HMAC thickness by 1" in lieu of lime treated subgrade
- 10) Increase concrete thickness by 0.5" in lieu of lime treated subgrade.
- 11) Provide 18" of select fill (**Section 12.1.3**) in lieu of lime treatment

12.5 Additional Recommendations

Due the highly expansive nature of the subgrade, there is a risk of differential movement that could lead to non-uniform support of the pavement slab and consequent distress. Measures that are recommended to reduce this risk include:

1. Drainage surrounding the pavement edge should be sufficient to rapidly remove surface water from the vicinity of the pavement.



2. The subgrade should be crowned with at least a 2% cross slope to shed any water infiltration to the exterior.
3. The flex base beneath the pavement should be daylighted (i.e. able to drain entirely to the exterior of the pavement), preventing accumulation of water in the base section.
4. Impervious shoulders 6' wide will help to reduce moisture fluctuation beneath the pavement and consequent distress. Alternatively, vertical moisture barriers consisting of a vinyl membrane in a 6' deep trench backfilled with flowable fill are effective in reducing moisture fluctuations. Details can be provided upon request.

13.0 LIMITATIONS

Geotechnical design work is characterized by the presence of a calculated risk that soil and groundwater conditions may not have been fully revealed by the exploratory borings. This risk derives from the practical necessity of basing interpretations and design conclusions on a limited sampling of the subsoil stratigraphy at the project site. The number of borings and spacing is chosen in such a manner as to decrease the possibility of undiscovered anomalies, while considering the nature of loading, size and cost of the project. The recommendations given in this report are based upon the conditions that existed at the boring locations at the time they were drilled. The term "existing groundline" or "existing subgrade" refers to the ground elevations and soil conditions at the time of our field operations.

It is conceivable that soil conditions throughout the site may vary from those observed in the exploratory borings. If such discontinuities do exist, they may not become evident until construction begins or possibly much later. Consequently, careful observations by the geotechnical engineer must be made of the construction as it progresses to help detect significant and obvious deviations of actual conditions throughout the project area from those inferred from the exploratory borings. Should any conditions at variance with those noted in this report be encountered during construction, this office should be notified immediately so that further investigations and supplemental recommendations can be made.

Construction plans and specifications should be submitted to E TTL for review prior to issuance for construction to help verify that the recommendations of this report have been correctly understood and implemented.

This company is not responsible for the conclusions, opinions, or recommendations made by others based on the contents of this report. The recommendations made in this report are applicable only to the proposed scope of work as defined in **SECTION 2.0 PROJECT DESCRIPTION** and may not be used for any other work without the express written consent of E TTL Engineers. The purpose of this study is only as stated elsewhere herein and is not intended to comply with the requirements of 30 TAC 330 Subchapter T regarding testing to determine the presence of a landfill. Our professional services have been performed, our findings obtained, and our recommendations prepared in



accordance with generally accepted geotechnical engineering principles and practices. No warranties are either expressed or implied.



Important Information about This

Geotechnical-Engineering Report

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

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

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer

will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

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

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

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the “Findings” Related in This Report Are Professional Opinions

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

This Report’s Recommendations Are Confirmation-Dependent

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

This Report Could Be Misinterpreted

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

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals’ plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

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

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note*

conspicuously that you’ve included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled “limitations,” many of these provisions indicate where geotechnical engineers’ responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a “phase-one” or “phase-two” environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer’s services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer’s recommendations will not of itself be sufficient to prevent moisture infiltration.* *Confront the risk of moisture infiltration* by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists.*

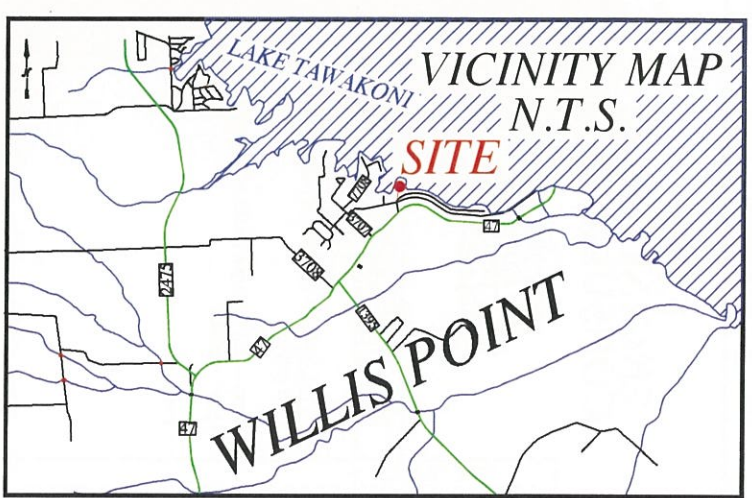
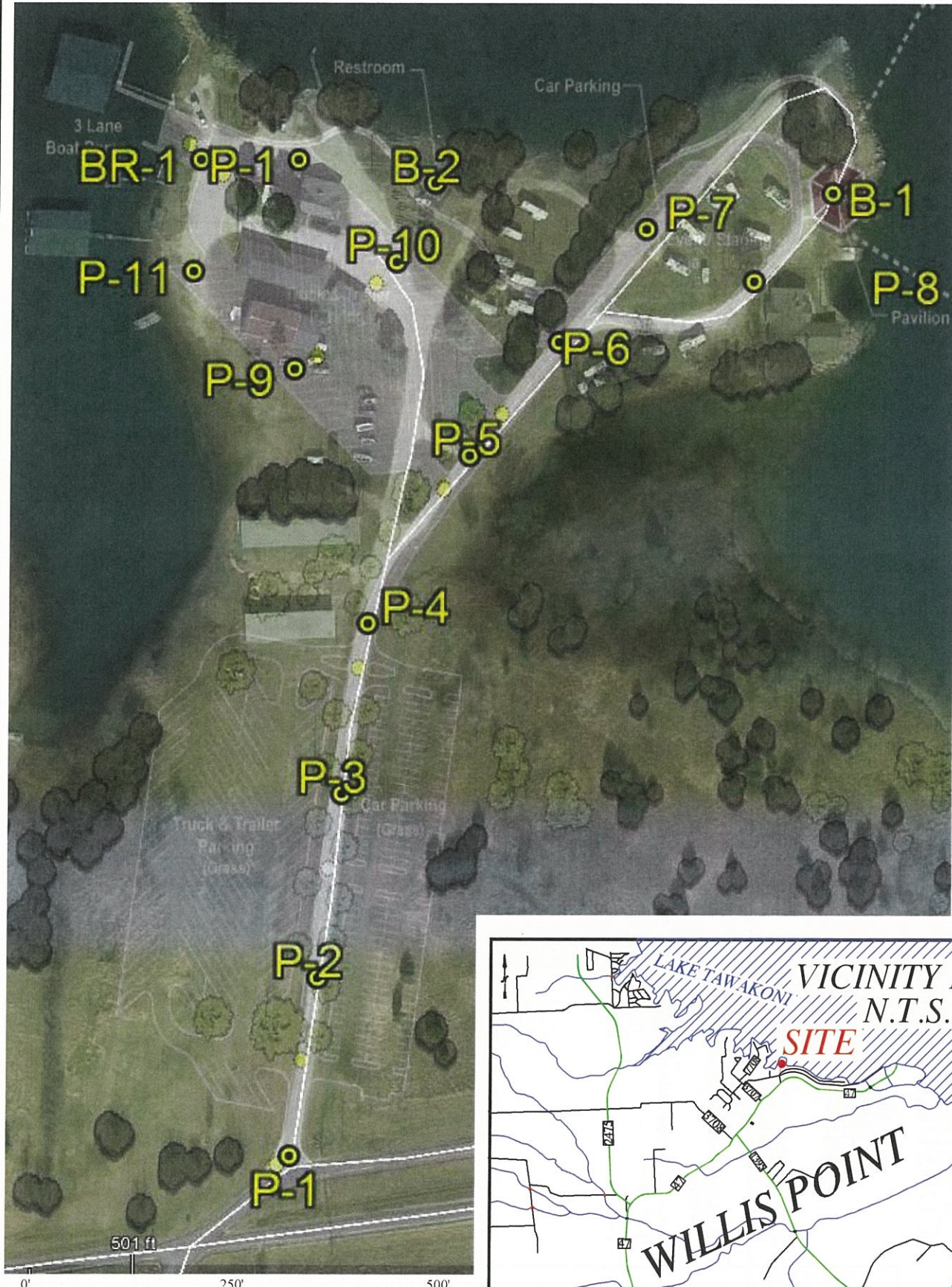


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APPENDIX A
Plan of Borings and Boring Logs



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LAKE TAWAKONI
 HOLIDAY MARINA
 WILLIS POINT, TEXAS

PLATE I - PLAN OF BORINGS
 JOB No.: G5378-20
 DATE: MARCH 2020 SCALE: AS SHOWN

APPROVED BY:
 DRAWN BY:
 A.K.B.

LOG OF BORING B-1

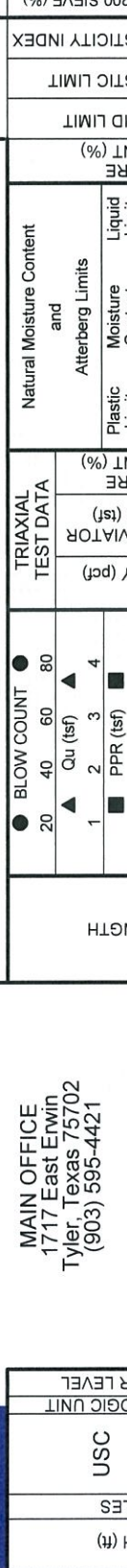
PROJECT: Lake Tawakoni Holiday Marina
 Wills Point, TX
PROJECT NO.: G5378-20
DRILL RIG: CME-75
BORING TYPE: Flight Auger

DATE: 3/2/20
SURFACE ELEVATION:

ATTERBERG LIMITS (%)
 LL LIQUID LIMIT
 PL PLASTIC LIMIT
 PI PLASTICITY INDEX

SIEVE ANALYSIS
 MINUS #200 SIEVE (%)
 PLUS #40 SIEVE (%)
 PLUS #4 SIEVE (%)

SWELL TEST
 DRY DENSITY (pcf)
 FREE SWELL (%)
 ZERO SWELL PRESSURE (ksf)
 MOISTURE CONTENT (%)



DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL
0				
5				
10				
15				
20				
25				

FIELD STRENGTH	BLOW COUNT	TRIAxIAL TEST DATA	Natural Moisture Content and Atterberg Limits	ATTERBERG LIMITS (%)	SWELL TEST
P=3.0	Qu (tsf) 1, 2, 3, 4 PPR (tsf) 1.0, 2.0, 3.0, 4.0 Torvane (tsf) 1.0, 2.0, 3.0, 4.0	Density (pcf) 98 Max Deviator Stress (tsf) 2.39 Moisture Content (%) 23	Plastic Limit, Moisture Content, Liquid Limit	LL 63, PL 17, PI 46 MINUS #200 SIEVE (%) 88 PLUS #40 SIEVE (%) 3 PLUS #4 SIEVE (%) 1	Density (pcf), Free Swell (%), Zero Swell Pressure (ksf), Moisture Content (%)
P=2.5					
P=2.5					
P=2.25					
P=3.0					
P=3.75					
P=3.75					

MATERIAL DESCRIPTION
 FAT CLAY(CH) stiff; brown; moist; with minor gravel
 --brown and light gray with orangish brown; mottled
 --with SM partings
 --dark gray and light brown with light gray; blocky
 --very stiff
 Bottom of Boring @ 25'

Key to Abbreviations: N - SPT Data (blows/ft)
 P - Pocket Penetrometer (tsf)
 T - Torvane (tsf)
 L - Lab Vane Shear (tsf)
 Tx - Texas Cone Penetrometer (blows/ft)

Notes:
 Dry and open upon completion.

GPS Coordinates:
 N32.813018°, W95.940559°
 Driller: E. Felker
 Logger: Marco



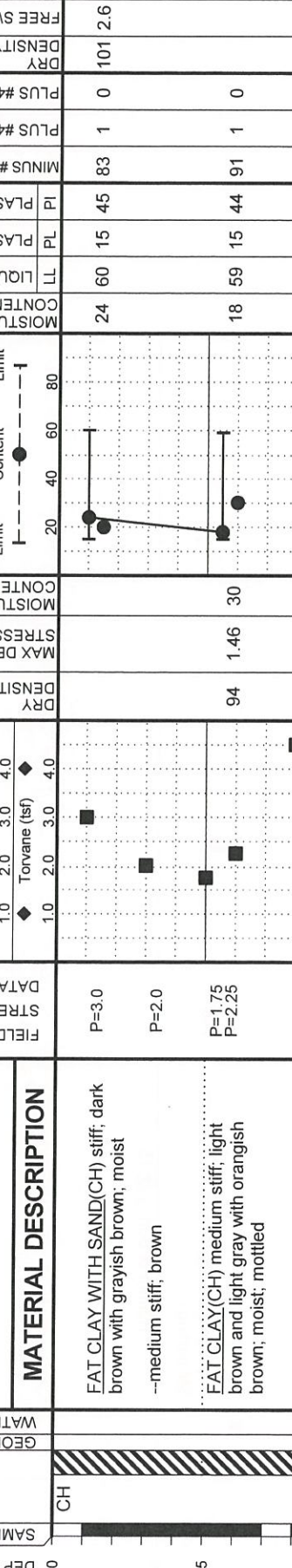
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LOG OF BORING B-2
 PROJECT: Lake Tawakoni Holiday Marina
 Willis Point, TX
 PROJECT NO.: G5378-20

DRILL RIG: CME-55 Track Rig
 BORING TYPE: Flight Auger

DATE: 3/2/20
 SURFACE ELEVATION



DEPTH (ft)	FIELD STRENGTH DATA	BLOW COUNT	DRY DENSITY (pcf)	MAX DEVIATOR STRESS (tsf)	MOISTURE CONTENT (%)	Plastic Limit	Moisture Content	Liquid Limit	Atterberg Limits	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	MINUS #200 SIEVE (%)	PLUS #40 SIEVE (%)	PLUS #4 SIEVE (%)	DENSITY (pcf)	FREE SWELL (%)	ZERO SWELL PRESSURE (ksf)	MOISTURE CONTENT (%)
0-20	P=3.0	Qu (tsf) 2.0, 3.0, 4.0; PPR (tsf) 2.0, 3.0, 4.0; Torvane (tsf) 1.0, 2.0, 3.0, 4.0	94	1.46	30	24	18	27	24	27	77	15	45	83	1	0	101	2.6	2.63	20
	P=2.0																			
	P=1.75, P=2.25																			
	P=4.5																			
	P=3.25																			
	P=4.25																			

MATERIAL DESCRIPTION
 FAT CLAY WITH SAND(CH) stiff; dark brown with grayish brown; moist
 --medium stiff; brown
 FAT CLAY(CH) medium stiff; light brown and light gray with orangish brown; moist; mottled
 --hard; gray and light brown with light gray; blocky, with SM partings
 --very stiff
 --hard
 Bottom of Boring @ 20'

Water Level
 Water Observations: Water @ 19' and open upon completion.

Est.: Measured: Perched:

Water Level: [Symbol]

Water Observations: Water @ 19' and open upon completion.

Est.:

Measured: [Symbol]

Perched: [Symbol]

Key to Abbreviations: N - SPT Data (blows/ft), P - Pocket Penetrometer (tsf), T - Torvane (tsf), L - Lab Vane Shear (tsf), Tx - Texas Cone Penetrometer (blows/ft)

Notes:

GPS Coordinates: N32.813051°, W95.942135°

Driller: Michael

Logger: E. Felker



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LOG OF BORING BR-1

PROJECT: Lake Tawakoni Holiday Marina
Wills Point, TX
PROJECT NO.: G5378-20

DRILL RIG: CME-75

BORING TYPE: Flight Auger

DATE

3/2/20

SURFACE ELEVATION

FIELD DATA	BLOW COUNT	TRIAxIAL TEST DATA				DRY DENSITY (pcf)	MAX DEVIATOR STRESS (tsf)	MOISTURE CONTENT (%)	Natural Moisture Content and Atterberg Limits		LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	SEIVE ANALYSIS			SWELL TEST		
		1	2	3	4				PL	PI				MINUS #200 SIEVE (%)	PLUS #40 SIEVE (%)	PLUS #4 SIEVE (%)	DRY DENSITY (pcf)	FREE SWELL (%)	ZERO SWELL PRESSURE (ksf)
P=1.25	1	2	3	4	1.0	2.0	3.0	4.0	23	53	14	39	81	1	0				
P=1.25	1	2	3	4	1.0	2.0	3.0	4.0	29	71	19	52	99	0	0				
P=2.25	1	2	3	4	1.0	2.0	3.0	4.0											
P=2.25	1	2	3	4	1.0	2.0	3.0	4.0											
P=2.5	1	2	3	4	1.0	2.0	3.0	4.0											

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION
0					
5					FAT CLAY WITH SAND(CH) medium stiff; grayish brown; moist
10					FAT CLAY(CH) stiff; light gray with light brown; moist; mottled
15					--very moist; blocky
					--light gray and light brown; moist; with SM partings
					Bottom of Boring @ 15'

Water Level: Measured; Perched; Seepage @ 8'. Water @ 12.5' and open to 13.5 upon completion.

Key to Abbreviations: N - SPT Data (blows/ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Tx - Texas Cone Penetrometer (blows/ft)

Notes:

GPS Coordinates: N32.813126°, W95.943066°
Driller: Marco
Logger: E. Felker

LOG OF BORING P-1

PROJECT: Lake Tawakoni Holiday Marina
Wills Point, TX
PROJECT NO.: G5378-20

DRILL RIG: CME-55 Track Rig
BORING TYPE: Flight Auger

DATE: 3/2/20
SURFACE ELEVATION:



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WATER LEVEL
GEOLOGIC UNIT
SAMPLES
DEPTH (ft)

MATERIAL DESCRIPTION

FAT CLAY WITH SAND(CH) very hard; brown with dark gray; moist; mottled

Bottom of Boring @ 5'

FIELD STRENGTH DATA	BLOW COUNT	TRIAxIAL TEST DATA				LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	MINUS #200 SIEVE (%)	PLUS #40 SIEVE (%)	PLUS #4 SIEVE (%)	DRY DENSITY (pcf)	FREE SWELL (%)	ZERO SWELL PRESSURE (ksf)	MOISTURE CONTENT (%)
		DRY DENSITY (pcf)	MAX DEVIATOR STRESS (tsf)	MOISTURE CONTENT (%)	NATURAL MOISTURE CONTENT and Atterberg Limits										
P=4.5+	1.0	2.0	3.0	4.0	19	56	40	81	1	0	111	2.7	4.37	18	
P=4.5+	1.0	2.0	3.0	4.0											

Notes:

Key to Abbreviations: N - SPT Data (blows/ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Tx - Texas Cone Penetrometer (blows/ft)

Water Level Est.: Measured: Perched:

Water Observations: Dry and open upon completion.

GPS Coordinates: N32.809816°, W95.942690°

Driller: Michael
Logger: E. Felker



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USC

GEOLOGIC UNIT

WATER LEVEL

SAMPLES

DEPTH (ft)

MATERIAL DESCRIPTION

FAT CLAY(CH) very stiff; brown with light brown; moist; with SM partings
--hard; brown and light gray with light brown; mottled; with iron ore and calcareous gravel

Bottom of Boring @ 5'

LOG OF BORING P- 2

PROJECT: Lake Tawakoni Holiday Marina
Wills Point, TX

PROJECT NO.: G5378-20

DRILL RIG: CME-55 Track Rig

BORING TYPE: Flight Auger

DATE

3/2/20

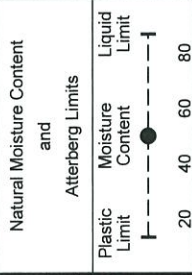
SURFACE ELEVATION

ATTERBERG LIMITS(%)

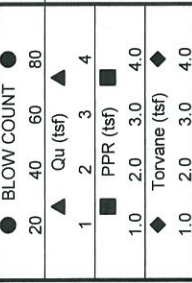
SIEVE ANALYSIS

SWELL TEST

LIQUID LIMIT	66	19	47	87	4	2				
PLASTIC LIMIT										
PLASTICITY INDEX										
MINUS #200 SIEVE (%)										
PLUS #40 SIEVE (%)										
PLUS #4 SIEVE (%)										
DRY DENSITY (pcf)										
FREE SWELL (%)										
ZERO SWELL PRESSURE (ksf)										
MOISTURE CONTENT (%)										



DRY DENSITY (pcf)	
MAX DEVIATOR STRESS (tsf)	
MOISTURE CONTENT (%)	



FIELD STRENGTH	P=3.75
DATA	P=4.5

USC

GEOLOGIC UNIT

WATER LEVEL

SAMPLES

DEPTH (ft)

MATERIAL DESCRIPTION

FAT CLAY(CH) very stiff; brown with light brown; moist; with SM partings
--hard; brown and light gray with light brown; mottled; with iron ore and calcareous gravel

Bottom of Boring @ 5'

Water Level	Est.:	Measured:	Perched:
Water Observations:	Dry and open upon completion.		
Key to Abbreviations: N - SPT Data (blows/ft) P - Pocket Penetrometer (tsf) T - Torvane (tsf) L - Lab Vane Shear (tsf) Tx - Texas Cone Penetrometer (blows/ft)			
Notes:			
GPS Coordinates:		Diller:	
N32.810407°, W95.942582°		Michael	
Logger:		E. Felker	



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LOG OF BORING P-3

PROJECT: Lake Tawakoni Holiday
Marina
Willis Point, TX
PROJECT NO.: G5378-20

DRILL RIG: CME-55 Track
Rig

BORING TYPE: Flight Auger

DATE: 3/2/20

SURFACE ELEVATION

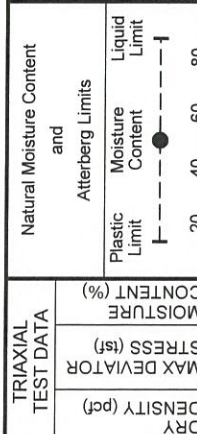
DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL
0				
5		CL		

MATERIAL DESCRIPTION

LEAN CLAY WITH SAND(CL) hard;
gray with light gray and reddish brown;
slightly moist; mottled; with SM partings
--very stiff; brown, light brown and gray;
with minor iron ore gravel

Bottom of Boring @ 5'

FIELD STRENGTH DATA	BLOW COUNT				TRIAXIAL TEST DATA			
	20	40	60	80	DRY DENSITY (pcf)	MAX DEVIATOR STRESS (tsf)	MOISTURE CONTENT (%)	MOISTURE CONTENT (%)
P=4.5	▲	▲	▲	▲	●			
P=4.0	■	■	■	■	◆			



ATTERBERG LIMITS(%)	SIEVE ANALYSIS			SWELL TEST
	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	
LL	42	14	28	
PL				
PI				
MOISTURE CONTENT (%)				
DRY DENSITY (pcf)				
FREE SWELL (%)				
ZERO SWELL PRESSURE (ksf)				
PLUS #200 SIEVE (%)				
PLUS #40 SIEVE (%)				
PLUS #4 SIEVE (%)				

Key to Abbreviations:
N - SPT Data (blows/ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Tx - Texas Cone Penetrometer (blows/ft)

Notes:

GPS Coordinates: N32.811019°, W95.942492°

Driller: Michael
Logger: E. Felker

Water Level: Measured: Perched:

Water Observations: Dry and open upon completion.



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MATERIAL DESCRIPTION

FAT CLAY WITH SAND(CH) very stiff;
brown; moist
--hard; light brown with light gray and
gray; mottled; with SM and calcareous
gravel partings
Bottom of Boring @ 5'

DEPTH (ft)	0	5
SAMPLES		
USC		
GEOLOGIC UNIT		
WATER LEVEL		

LOG OF BORING P-4

PROJECT: Lake Tawakoni Holiday
Marina
Wills Point, TX

PROJECT NO.: G5378-20

DRILL RIG: CME-55 Track
Rig

BORING TYPE: Flight Auger

DATE

3/2/20

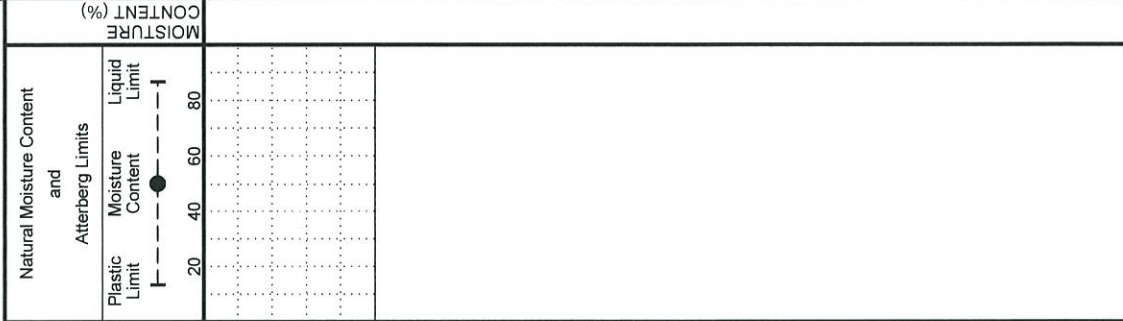
SURFACE ELEVATION

ATTERBERG LIMITS(%)

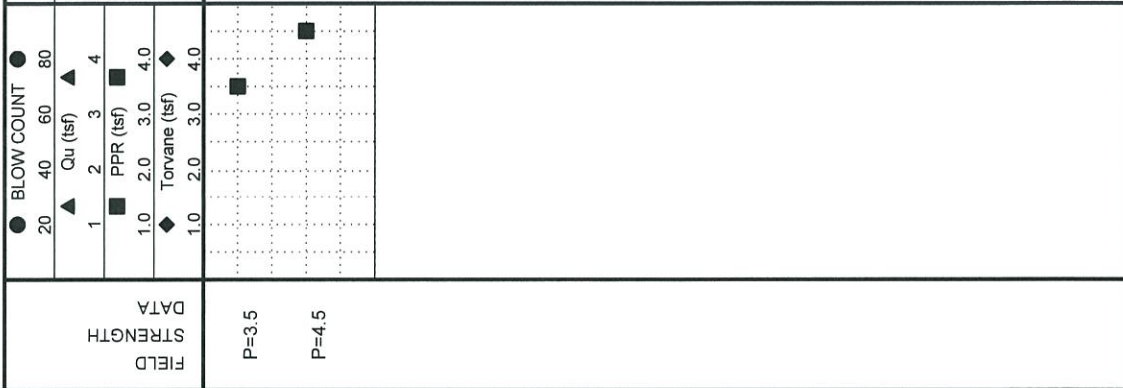
SIEVE ANALYSIS

SWELL TEST

LIQUID LIMIT	PL	PLASTIC LIMIT	PI	PLASTICITY INDEX	PI	MINUS #200 SIEVE (%)	PLUS #40 SIEVE (%)	PLUS #4 SIEVE (%)	DRY DENSITY (pcf)	FREE SWELL (%)	ZERO SWELL PRESSURE (ksf)	MOISTURE CONTENT (%)



FIELD STRENGTH	P=3.5	P=4.5
DATA		
DRY DENSITY (pcf)		
MAX DEVIATOR STRESS (tsf)		
MOISTURE CONTENT (%)		



Notes:

Key to Abbreviations: N - SPT Data (blows/ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Tx - Texas Cone Penetrometer (blows/ft)

Water Level Est.: Measured: Perched:
Water Observations: Dry and open upon completion.

GPS Coordinates: N32.811586°, W95.942392°
Driller: Michael
Logger: E. Felker

LOG OF BORING P- 5

PROJECT: Lake Tawakoni Holiday Marina Willis Point, TX
DRILL RIG: CME-55 Track Rig
DATE: 3/2/20
SURFACE ELEVATION:

PROJECT NO.: G5378-20
BORING TYPE: Flight Auger

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	TRIAxIAL TEST DATA				MOISTURE CONTENT (%)	Natural Moisture Content and Atterberg Limits	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	MINUS #200 SIEVE (%)	PLUS #40 SIEVE (%)	PLUS #4 SIEVE (%)	DRY DENSITY (pcf)	FREE SWELL (%)	ZERO SWELL PRESSURE (ksf)	MOISTURE CONTENT (%)
					BLOW COUNT	DRY DENSITY (pcf)	MAX DEVIATOR STRESS (tsf)	MOISTURE CONTENT (%)												
0																				
5			CH																	

MATERIAL DESCRIPTION
 FAT CLAY WITH SAND(CH) stiff; gray and light brown; moist; mottled --gray, light gray and light brown
 Bottom of Boring @ 5'



FIELD STRENGTH DATA	BLOW COUNT	DRY DENSITY (pcf)	MAX DEVIATOR STRESS (tsf)	MOISTURE CONTENT (%)	Natural Moisture Content and Atterberg Limits	PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX	MINUS #200 SIEVE (%)	PLUS #40 SIEVE (%)	PLUS #4 SIEVE (%)	DRY DENSITY (pcf)	FREE SWELL (%)	ZERO SWELL PRESSURE (ksf)	MOISTURE CONTENT (%)
P=2.75															
P=2.75															

Water Level
Water Observations: Dry and open upon completion.
Est.: Measured: Perched:
Key to Abbreviations: N - SPT Data (blows/ft)
 P - Pocket Penetrometer (tsf)
 T - Torvane (tsf)
 L - Lab Vane Shear (tsf)
 Tx - Texas Cone Penetrometer (blows/ft)



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MATERIAL DESCRIPTION

FAT CLAY(CH) medium stiff; brown;
moist
--stiff

Bottom of Boring @ 5'

DEPTH (ft)	0	5
SAMPLES		
USC		
GEOLOGIC UNIT		
WATER LEVEL		

LOG OF BORING P-6

PROJECT: Lake Tawakoni Holiday Marina
Wills Point, TX

PROJECT NO.: G5378-20

DRILL RIG: CME-55 Track Rig

BORING TYPE: Flight Auger

DATE

3/2/20

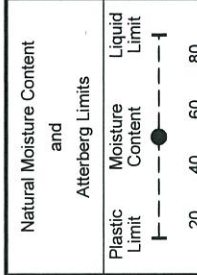
SURFACE ELEVATION

ATTERBERG LIMITS(%)

SIEVE ANALYSIS

SWELL TEST

LIQUID LIMIT	71	66	16	50	87	3	0			
PLASTIC LIMIT										
PLASTICITY INDEX										
PLUS #200 SIEVE (%)										
PLUS #40 SIEVE (%)										
PLUS #4 SIEVE (%)										
DRY DENSITY (pcf)										
FREE SWELL (%)										
ZERO SWELL PRESSURE (ksf)										
MOISTURE CONTENT (%)		19								



FIELD STRENGTH	P=2.0	P=2.75		
DATA				
TONVANE (tsf)	1.0	2.0	3.0	4.0
PPR (tsf)	1.0	2.0	3.0	4.0
QU (tsf)	1	2	3	4
BLOW COUNT	20	40	60	80

DRY DENSITY (pcf)	
MAX DEVIATOR STRESS (tsf)	
MOISTURE CONTENT (%)	
TRIAXIAL TEST DATA	

Notes:

Key to Abbreviations: N - SPT Data (blows/ft)
P - Pocket Penetrometer (tsf)
T - Tonvane (tsf)
L - Lab Vane Shear (tsf)
Tx - Texas Cone Penetrometer (blows/ft)

Water Level
Water Observations: Est.: Measured: Perched:
Dry and open upon completion.

GPS Coordinates: N32.812523°, W95.941641°
Driller: Michael
Logger: E. Felker



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MATERIAL DESCRIPTION

FAT CLAY(CH) very hard; brown;
moist; with calcareous gravel

Bottom of Boring @ 5'

DEPTH (ft)	0	5
SAMPLES		
USC		
GEOLOGIC UNIT		
WATER LEVEL		

LOG OF BORING P-8

PROJECT: Lake Tawakoni Holiday
Marina
Wills Point, TX

PROJECT NO.: G5378-20

BORING TYPE: Flight Auger

DRILL RIG: CME-75

DATE

3/2/20

SURFACE ELEVATION

FIELD STRENGTH DATA	BLOW COUNT	TRIAxIAL TEST DATA			Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	ID PLASTICITY INDEX	SIEVE ANALYSIS			SWELL TEST			
		DENSITY (pcf)	MAX DEVIATOR STRESS (tsf)	MOISTURE CONTENT (%)						PL	PL	PLUS #200 SIEVE (%)	PLUS #40 SIEVE (%)	PLUS #4 SIEVE (%)	DRY DENSITY (pcf)	FREE SWELL (%)
P=4.5+	<ul style="list-style-type: none"> ● 20 ▲ 1 ■ 1.0 ◆ 1.0 	<ul style="list-style-type: none"> ● 20 ▲ 2 ■ 2.0 ◆ 2.0 	<ul style="list-style-type: none"> ● 40 ▲ 3 ■ 3.0 ◆ 3.0 	<ul style="list-style-type: none"> ● 80 ▲ 4 ■ 4.0 ◆ 4.0 		18	69	19	50	90	3	1				
P=4.5+																

Water Level Est.: Measured: Perched:

Water Observations: Dry and open upon completion.

Notes:

Key to Abbreviations: N - SPT Data (blows/ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Tx - Texas Cone Penetrometer (blows/ft)

GPS Coordinates: N32.812725°, W95.940869°

Diller: Marco
Logger: E. Felker

LOG OF BORING P- 9

DATE 3/2/20
SURFACE ELEVATION

PROJECT: Lake Tawakoni Holiday Marina Willis Point, TX
DRILL RIG: CME-55 Track Rig
BORING TYPE: Flight Auger
PROJECT NO.: G5378-20

ETTL ENGINEERS & CONSULTANTS
 MAIN OFFICE
 1717 East Erwin
 Tyler, Texas 75702
 (903) 595-4421

DEPTH (ft)	SAMPLES	GEOLOGIC UNIT	WATER LEVEL	FIELD STRENGTH DATA	BLOW COUNT	TRIAxIAL TEST DATA			Natural Moisture Content and Atterberg Limits	ATTERBERG LIMITS(%)	SIEVE ANALYSIS	SWELL TEST																					
						DRY DENSITY (pcf)	MAX DEVIATOR STRESS (tsf)	MOISTURE CONTENT (%)																									
0		USC			<table border="1" style="width: 100%; text-align: center;"> <tr> <td>●</td> <td>▲</td> <td>■</td> <td>◆</td> </tr> <tr> <td>20</td> <td>2</td> <td>2.0</td> <td>1.0</td> </tr> <tr> <td>40</td> <td>3</td> <td>3.0</td> <td>2.0</td> </tr> <tr> <td>60</td> <td>4</td> <td>4.0</td> <td>3.0</td> </tr> <tr> <td>80</td> <td></td> <td></td> <td>4.0</td> </tr> </table>	●	▲	■	◆	20	2	2.0	1.0	40	3	3.0	2.0	60	4	4.0	3.0	80			4.0								
●	▲	■	◆																														
20	2	2.0	1.0																														
40	3	3.0	2.0																														
60	4	4.0	3.0																														
80			4.0																														
5		CH		FIELD STRENGTH: P=1.25, P=2.75 DATA:																													

MATERIAL DESCRIPTION
 FAT CLAY(CH) medium stiff; brown; moist
 --stiff; light brown and light gray; mottled; with calcareous gravel
 Bottom of Boring @ 5'

Water Level
 Water Observations: Dry and open upon completion.

Est.: Measured: Perched:

Notes:
 Key to Abbreviations: N - SPT Data (blows/ft)
 P - Pocket Penetrometer (tsf)
 T - Torvane (tsf)
 L - Lab Vane Shear (tsf)
 Tx - Texas Cone Penetrometer (blows/ft)

GPS Coordinates: N32.812432° W95.942691°
 Driller: Michael
 Logger: E. Felker



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MATERIAL DESCRIPTION

FAT CLAY(CH) stiff; brown with reddish brown; moist; mottled; with calcareous gravel

Bottom of Boring @ 5'

DEPTH (ft)	0
SAMPLES	
USC	
GEOLOGIC UNIT	
WATER LEVEL	

LOG OF BORING P-10

PROJECT: Lake Tawakoni Holiday Marina
Wills Point, TX

PROJECT NO.: G5378-20

DRILL RIG: CME-75

BORING TYPE: Flight Auger

DATE

3/2/20

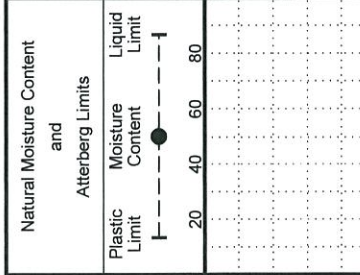
SURFACE ELEVATION

ATTERBERG LIMITS(%)

SIEVE ANALYSIS

SWELL TEST

LIQUID LIMIT	
PLASTIC LIMIT	
PLASTICITY INDEX	
MINUS #200 SIEVE (%)	
PLUS #40 SIEVE (%)	
PLUS #4 SIEVE (%)	
DRY DENSITY (pcf)	
FREE SWELL (%)	
ZERO SWELL PRESSURE (ksf)	
MOISTURE CONTENT (%)	



FIELD STRENGTH	P=2.25
DATA	P=2.25
DRY DENSITY (pcf)	
MAX DEVIATOR STRESS (tsf)	
MOISTURE CONTENT (%)	
TRIAxIAL TEST DATA	
BLOW COUNT	
Qu (tsf)	
PPR (tsf)	
Tonvane (tsf)	

Water Level	Est.: <input type="checkbox"/> Measured: <input checked="" type="checkbox"/> Perched: <input checked="" type="checkbox"/>
Water Observations:	Dry and open upon completion.
Notes:	Key to Abbreviations: N - SPT Data (blows/ft) P - Pocket Penetrometer (tsf) T - Tonvane (tsf) L - Lab Vane Shear (tsf) Tx - Texas Cone Penetrometer (blows/ft)
GPS Coordinates:	N32.812788°, W95.942287°
Driller:	Marco
Logger:	E. Felker



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Tyler, Texas 75702
(903) 595-4421

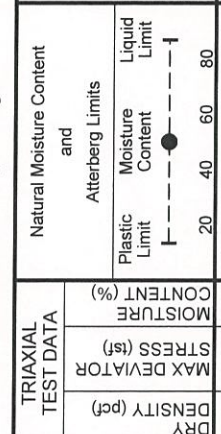
LOG OF BORING P-11
PROJECT: Lake Tawakoni Holiday Marina
Wills Point, TX
PROJECT NO.: G5378-20
DRILL RIG: CME-55 Track Rig
BORING TYPE: Flight Auger

DATE: 3/2/20
SURFACE ELEVATION

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL
0				
5		CH		

MATERIAL DESCRIPTION
FAT CLAY WITH SAND(CH) medium stiff; brown; moist
--light brown and light gray; mottled
Bottom of Boring @ 5'

FIELD STRENGTH DATA	BLOW COUNT ● 20 40 60 80 ▲ Cu (tsf) 1 2 3 4 ■ PPR (tsf) 1.0 2.0 3.0 4.0 ◆ Torvane (tsf) 1.0 2.0 3.0 4.0
P=2.0	
P=1.75	



TRIAXIAL TEST DATA	DRY DENSITY (pcf)	MAX DEVIATOR STRESS (tsf)	MOISTURE CONTENT (%)

FIELD STRENGTH DATA	ATTERBERG LIMITS(%)	SIEVE ANALYSIS	SWELL TEST
	TL LIQUID LIMIT PL PLASTIC LIMIT PI PLASTICITY INDEX	MINUS #200 SIEVE (%) PLUS #40 SIEVE (%) PLUS #4 SIEVE (%)	DRY DENSITY (pcf) FREE SWELL (%) ZERO SWELL PRESSURE (ksf) MOISTURE CONTENT (%)
		83 3 1	

Water Level
Water Observations: Est.: Measured: Perched:
Dry and open upon completion.

Key to Abbreviations: N - SPT Data (blows/ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)
Tx - Texas Cone Penetrometer (blows/ft)

Notes:

GPS Coordinates: N32.812756°, W95.943093°
Driller: Michael
Logger: E. Felker



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MATERIAL DESCRIPTION

FAT CLAY WITH SAND(CH) medium stiff; grayish brown; moist

Bottom of Boring @ 5'

DEPTH (ft)	0	5
SAMPLES		
USC		
GEOLOGIC UNIT		
WATER LEVEL		

LOG OF BORING P-12

PROJECT: Lake Tawakoni Holiday Marina
Wills Point, TX

PROJECT NO.: G5378-20

BORING TYPE: Flight Auger

DRILL RIG: CME-75

DATE

3/2/20

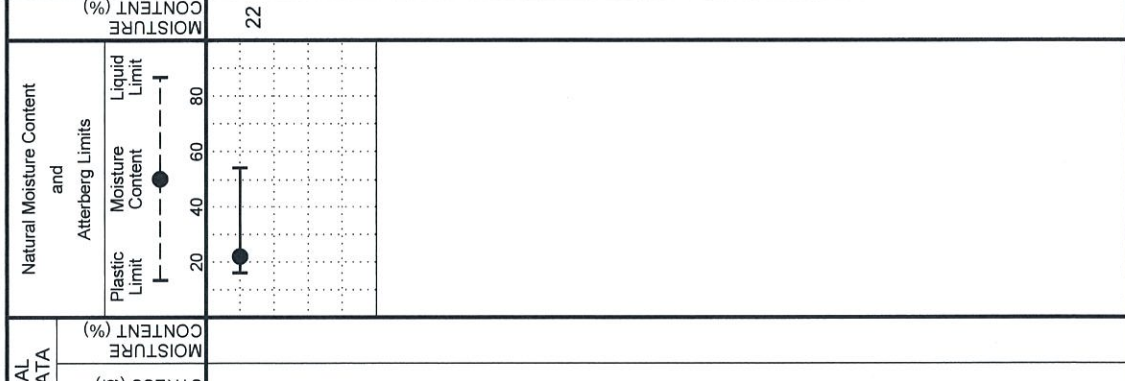
SURFACE ELEVATION

ATTERBERG LIMITS(%)

SIEVE ANALYSIS

SWELL TEST

LIQUID LIMIT	TL	54	16	38	78	4	1						
PLASTIC LIMIT	PL												
PLASTICITY INDEX	PI												
MINUS #200 SIEVE (%)													
PLUS #40 SIEVE (%)													
PLUS #4 SIEVE (%)													
DRY DENSITY (pcf)													
FREE SWELL (%)													
ZERO SWELL PRESSURE (ksf)													
MOISTURE CONTENT (%)													



FIELD STRENGTH													
DATA													
DRY DENSITY (pcf)													
MAX DEVIATOR STRESS (tsf)													
MOISTURE CONTENT (%)													
TRIAxIAL TEST DATA													
BLOW COUNT													
Qu (tsf)													
PPR (tsf)													
Tonvane (tsf)													

Notes:

Key to Abbreviations: N - SPT Data (blows/ft)
P - Pocket Penetrometer (tsf)
T - Tonvane (tsf)
L - Lab Vane Shear (tsf)
Tx - Texas Cone Penetrometer (blows/ft)

Water Level

Water Observations: Measured; Perched; Dry and open upon completion.

GPS Coordinates: N32.813126°, W95.942680°

Driller: Marco

Logger: E. Felker

Boring Log Descriptive Terminology

Key to Soil Symbols and Terms

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	Well-graded gravels, gravel sand mixtures, little or no fines.
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	Silty gravels, gravel-sand-silt mixtures.
	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	Well-graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	Silty sands, sand-silt mixtures.
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		LIQUID LIMIT LESS THAN 50		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		LIQUID LIMIT LESS THAN 50		OL	Organic silts and organic silty clays of low plasticity.
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		LIQUID LIMIT GREATER THAN 50		CH	Inorganic clays of high plasticity, fat clays.
		LIQUID LIMIT GREATER THAN 50		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils.	

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Notes

SPT (Standard Penetration Test-ASTM D1586):

The number of blows of a 140 lb (63.6 kg) hammer falling 2.5 ft (750 mm) used to drive a 2 in (50 mm) O.D. Split Spoon sampler for a total of 1.5 ft (0.45 m) of penetration.

Written as follows:

first 0.5 ft (0.15 m) - second 0.5 ft (0.15 m) - third 0.5 ft (0.15 m)
(ex: 1-3-9)

Note: if the number of blows exceeds 50 before 0.5 ft (0.15 m) of penetration is achieved, the actual penetration follows the number of blows in parentheses
(ex: 12-24-50 (0.09 m), 34-50 (0.4 ft), or 100 (0.3 ft)).

WR denotes a zero blow count with the weight of the rods only.

WH denotes a zero blow count with the weight of the rods plus the weight of the hammer.

Soil Classifications are Based on the Unified Soil Classification System, ASTM D2487 and D2488.

Also included are the AASHTO group classifications (M145). Descriptions are based on visual observation, except where they have been modified to reflect results of laboratory tests as deemed appropriate.

Order of Descriptors

- Group Name
- Consistency or Relative Density
- Moisture Condition
- Color
- Particle size descriptor(s) (coarse grained soils only)
- Angularity of coarse grained soils
- Other relevant notes

Criteria For Descriptors

Consistency of Fine Grained Soils

Consistency	N-Value (uncorrected)
Very Soft	< 2
Soft	2 - 4
Medium Stiff	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	> 30

Apparent Density of Coarse Grained Soils

Relative Density	N-Value (uncorrected)
Very Loose	< 4
Loose	4 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	> 50

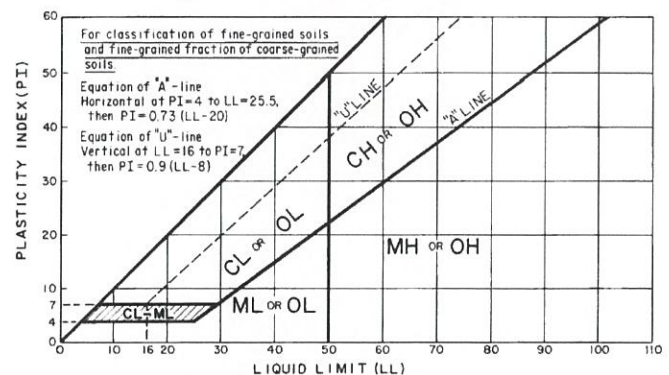
Moisture Condition

- Dry Moist Wet
- Absence of moisture, dusty, dry to the touch.
 - Damp, but no visible water.
 - Visible free water.

Definition of Particle Size Ranges

Soil Component	Size Range
Boulder	> 12 in (300 mm)
Cobble	3 in (75 mm) - 12 in (300 mm)
Gravel	No. 4 Sieve (4.75 mm) to 3 in (75 mm)
Sand	No. 200 (0.075 mm) to No. 4 Sieves (4.75 mm)
Silt	< No. 200 Sieve (0.075 mm)*
Clay	< No. 200 Sieve (0.075 mm)*

*Use Atterberg limits and chart below to differentiate between silt and clay.



Angularity of Coarse-Grained Particles

- Angular** -Particles have sharp edges and relative plane sides with unpolished surfaces.
- Subangular** -Particles are similar to angular description, but have rounded edges.
- Subrounded** -Particles have nearly plane sides, but have no edges.
- Rounded** -Particles have smoothly curved sides and well-rounded corners and edges.

APPENDIX B

Laboratory Testing Reports



ETTL Engineers & Consultants Inc.

GEOTECHNICAL * MATERIALS * ENVIRONMENTAL * DRILLING * LANDFILLS

LABORATORY TEST DATA SUMMARY SHEET

PROJECT: Lake Tawakoni Holiday Marina

ETTL JOB NUMBER: G 5378-20

PROJECT LOCATION: Willis Point, TX

CLIENT: Steve Hobbs, P.E.

PROJECT MANAGER: Steve Richards

START DATE: 3/4/2020

FINISH DATE: 3/11/2020

TECHNICIAN(S): Micah

DATE SAMPLED: 3/2/2020

Boring No.	Depth (ft.) Top Bott	Sample No.	Description of Sample	USCS Classification	Atterberg Limits			Moisture Content (%)	Dry Unit Weight (pcf)	Moisture Content (%)	Compressive Strength (ksf)	Failure Strain (%)	Confining Pressure (psi)	Consol. / Swell Tests Results					
					LL	PL	PI							Dry Unit Weight (pcf)	Moisture Content (%)	Free Swell (%)	Restraining Pressure (ksf)		
BR-1	3	5	Grayish Brown	CH	Fat Clay with Sand	53	14	39	23	81									
BR-1	8	10	Lt Gray w/ Lt Brown	CH	Fat Clay	71	19	52	29	99									
B-1	3	5	Br, Lt Gray w/ Orangish Br	CH	Fat Clay	63	17	46	22	88	3	1	97.7	23.1	2.39	6.10	3.20		
B-2	1	3	Dark Gray w/ Grayish Br	CH	Fat Clay with Sand	60	15	45	24	83	1	0							
B-2	5	7	Lt Br, Lt Gray w/ Orangish Br	CH	Fat Clay	59	15	44	18	91	1	0	94.4	30.2	1.46	6.60	4.70		
B-2	13	15	Gray, Lt Br w/ Lt Gray	CH	Fat Clay	77	23	54	27	99	0	0							
B-2	18	20	Gray, Lt Br w/ Lt Gray	CH	Fat Clay	NT	NT	NT	NT	NT	NT	NT							
P-1	1	3	Br w/ Dark Gray	CH	Fat Clay with Sand	56	16	40	19	81	1	0							
P-2	3	5	Br, Lt Gray w/ Lt Br	CH	Fat Clay	66	19	47	21	87	4	2							
P-3	1	3	Gray w/ Lt Gray, Reddish Br	CL	Lean Clay with Sand	42	14	28	14	75	3	0							
P-5	1	3	Gray, Lt Br	CH	Fat Clay with Sand	53	15	38	21	81	2	0							
P-6	3	5	Brown	CH	Fat Clay	66	16	50	19	87	3	0							
P-7	3	5	Gray, Lt Br w/ Lt Gray	CH	Fat Clay	82	19	63	23	99	0	0							
P-8	1	3	Brown	CH	Fat Clay	69	19	50	18	90	3	1							
P-11	3	5	Lt Br, Lt Gray	CH	Fat Clay with Sand	55	16	39	23	83	3	1							
P-12	1	3	Grayish Brown	CH	Fat Clay with Sand	54	16	38	22	78	4	1							

NT = Not Tested, Visual Classification
NP = Non Plastic, LL Attempted

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GEOTECHNICAL * MATERIALS * ENVIRONMENTAL * DRILLING * LANDFILLS

ASTM D 4546 One-Dimensional Swell or Settlement of Cohesive Soils, Method A/B Modified

Project Information

Project: Lake Tawakoni Holiday Marina
 Client/Arch./Engr: Steve Hobbs, P.E.
 Project Location: Wills Point
 ETTL Job No: G 5378-20

Sample Information

Location / Boring No: B-2
 Sample No: _____ Depth: 1-3 ft.
 Material Origin: Geotechnical Boring
 Sampling Info. provided By: Evan Felker
 Material Description: Dark Gray with Orangish Brown Fat Clay with Sand, (CH)
 Sample Type: Undisturbed Shelby Tube trimmed at In-situ M.C.
 Sampled By: ETTL Drilling Date Sampled: 3/2/2020
 Technician: Tommy Burns Test Date: 3/7/2020

Test Data

	Sample Data				
	Molded	Overburden Consol.	Restrain Swell	Free Swell	
Wt. of mold + Wet Wt.:	190.34	190.34	190.34	196.84	grams
Wt. of mold:	68.97	68.97	68.97	68.97	grams
Wet Wt. of sample:	121.37	121.37	121.37	127.87	grams
Dry Wt. of sample:	101.18	101.18	101.18	101.18	grams
Height of sample:	0.7858	0.7801	0.7799	0.7998	inches
Diameter of sample:	2.500	2.500	2.500	2.500	inches
Area of sample:	4.909	4.909	4.909	4.909	in ²
Volume of sample:	3.857	3.829	3.828	3.926	in ³
Degree of Saturation:	79.9%	81.3%	81.4%	100.0%	
Void Ratio e:	0.667	0.655	0.655	0.697	
Applied Pressure:	125	375	2626	125	psf
Assumed Specific Gravity:	2.67	2.67	2.67	2.67	
Wet Unit Weight:	119.9	120.8	120.8	124.1	pcf
Dry Unit Weight:	99.9	100.7	100.7	98.2	pcf
Moisture Content:	20.0%	20.0%	20.0%	26.4%	

Atterberg Limits	
L.L.	P.L.
60	15
P.I.	-200%
45	83
*N/T = Not Tested	

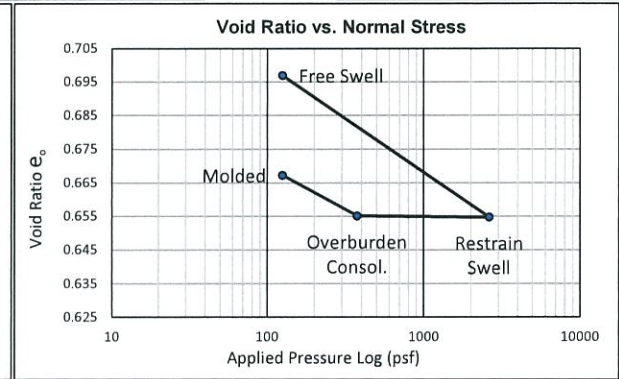
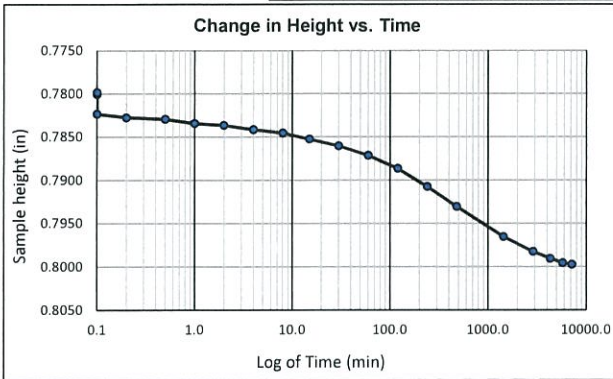
Pocket Penetrometer (tsf)	
Before Test	After Test
2.50	1.75

USACE Swelling Index - Cs	
0.032	

Percent Moisture Absorption	
6.4%	

Percent Free Swell	
2.6%	

Restrain Pressure (psf)	
2626	





ETTL Engineers & Consultants Inc.

GEOTECHNICAL * MATERIALS * ENVIRONMENTAL * DRILLING * LANDFILLS

ASTM D 4546 One-Dimensional Swell or Settlement of Cohesive Soils, Method A/B Modified

Project Information

Project: Lake Tawakoni Holiday Marina
 Client/Arch./Engr: Steve Hobbs, P.E.
 Project Location: Wills Point
 ETTL Job No: G 5378-20

Sample Information

Location / Boring No: P-1
 Sample No: _____ Depth: 1-3 ft.
 Material Origin: Geotechnical Boring
 Sampling Info. provided By: Evan Felker
 Material Description: Brown with Dark Gray Fat Clay with Sand, (CH)
 Sample Type: Undisturbed Shelby Tube trimmed at In-situ M.C.
 Sampled By: ETTL Drilling Date Sampled: 3/2/2020
 Technician: Tommy Burns Test Date: 3/7/2020

Test Data

Sample Data					
	Molded	Overburden Consol.	Restrain Swell	Free Swell	
Wt. of mold + Wet Wt.:	197.21	197.21	197.21	202.22	grams
Wt. of mold:	67.31	67.31	67.31	67.31	grams
Wet Wt. of sample:	129.90	129.90	129.90	134.91	grams
Dry Wt. of sample:	110.45	110.45	110.45	110.45	grams
Height of sample:	0.7760	0.7716	0.7717	0.7929	inches
Diameter of sample:	2.500	2.500	2.500	2.500	inches
Area of sample:	4.909	4.909	4.909	4.909	in ²
Volume of sample:	3.809	3.788	3.788	3.892	in ³
Degree of Saturation:	92.5%	94.1%	94.0%	100.0%	
Void Ratio e:	0.508	0.500	0.500	0.541	
Applied Pressure:	125	376	4373	125	psf
Assumed Specific Gravity:	2.67	2.67	2.67	2.67	
Wet Unit Weight:	129.9	130.7	130.6	132.1	pcf
Dry Unit Weight:	110.5	111.1	111.1	108.1	pcf
Moisture Content:	17.6%	17.6%	17.6%	22.1%	

Atterberg Limits	
L.L.	P.L.
56	16
P.I.	-200%
40	81

*N/T = Not Tested

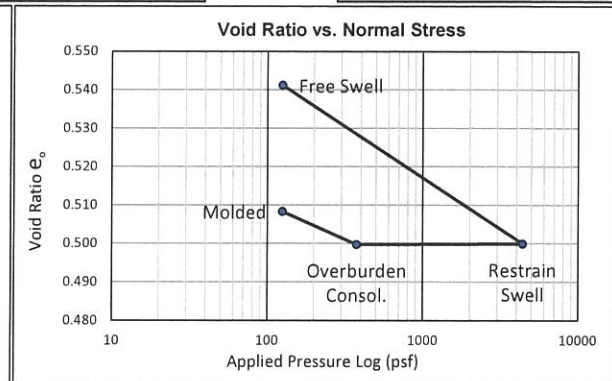
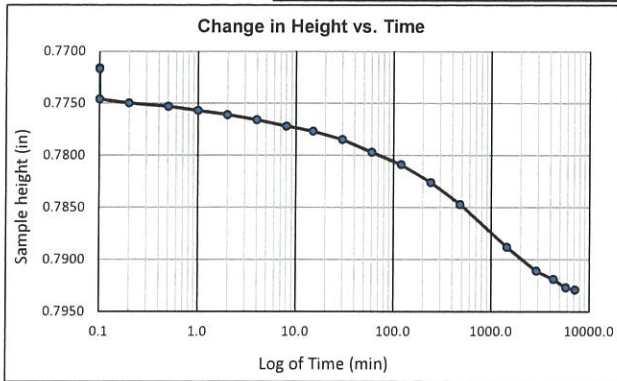
Pocket Penetrometer (tsf)	
Before Test	After Test
4.5+	3.25

USACE Swelling Index - Cs	
0.027	

Percent Moisture Absorption	
4.5%	

Percent Free Swell	
2.7%	

Restrain Pressure (psf)	
4373	





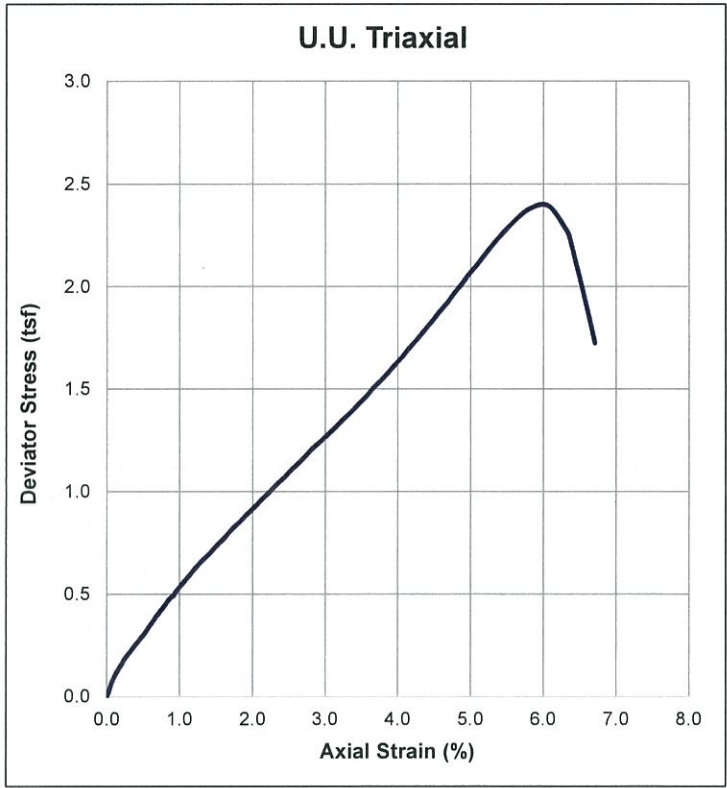
ETTL Engineers & Consultants Inc.

GEOTECHNICAL * MATERIALS * ENVIRONMENTAL * DRILLING * LANDFILLS

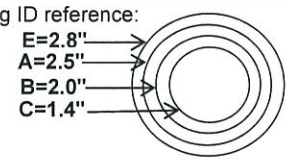
ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project: Lake Tawakoni Holiday Marina
 Client: Steve Hobbs, P.E.
 Location: Wills Point
 Material: Brown and Lt Gray with Orangish Brown Fat Clay, (CH)

ETTL Project No.: G 5378-20
 Boring No.: B-1
 Sample No. / Depth (ft.): 3.0'-5.0'
 Specimen Trimming ID: E (whole)
 Height: 5.543 inches
 Diameter: 2.657 inches
 Height / Diameter Ratio: 2.09
Initial Moisture Content: 23.1% (trimmings)
Initial Dry Unit Weight: 97.7 lbs./ft³
 Initial Total Unit Weight: 120.3 lbs./ft³
 Specific Gravity: 2.670 (assumed)
 Initial Void Ratio: 0.706
 Initial Saturation: 87.4 %
 Pocket Pentrometer: 4.50 tsf
 Hand Torvane: N/T tsf
 Rate of Strain: 1.0 %/min
Chamber Pressure: 3.2 psi
Peak Strain: 6.1 %
Cor. Maximum Deviator Stress: 2.39 tsf
 Cor. Maximum Deviator Stress: 4785 psf
 Cor. Maximum Deviator Stress: 33.2 psi
 Cor. Secant Modulus at 1/2 Peak Stress: 8.60E+04 psf
 Strain at 50% Max Stress (ϵ_{50}): 2.78E-02 in/in
 Initial Tangent Modulus: 2.10E+05 psf
 Atterbergs LL / PI: 63 | 46
 Passing No. 200 Sieve: 88.0 %
 Sampling Method: 2.8 in. Shelby Tube
 Type of Specimen: Undisturbed
 Date Sampled: 3/2/2020



Membrane Correction Factor Applied to Deviator Stress (tsf) = 0.026
 This test has been run to a maximum % strain of: 6.7



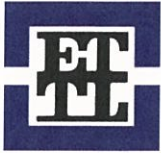
Measured Angle of Fracture from Horizontal: 70

Remarks: _____
 Technician: Tommy Burns Test Date: 3/7/2020 Report Date: 3/11/2020

Sketch of Fracture: _____



Shear



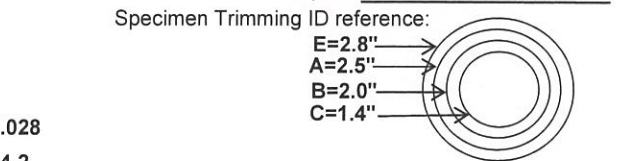
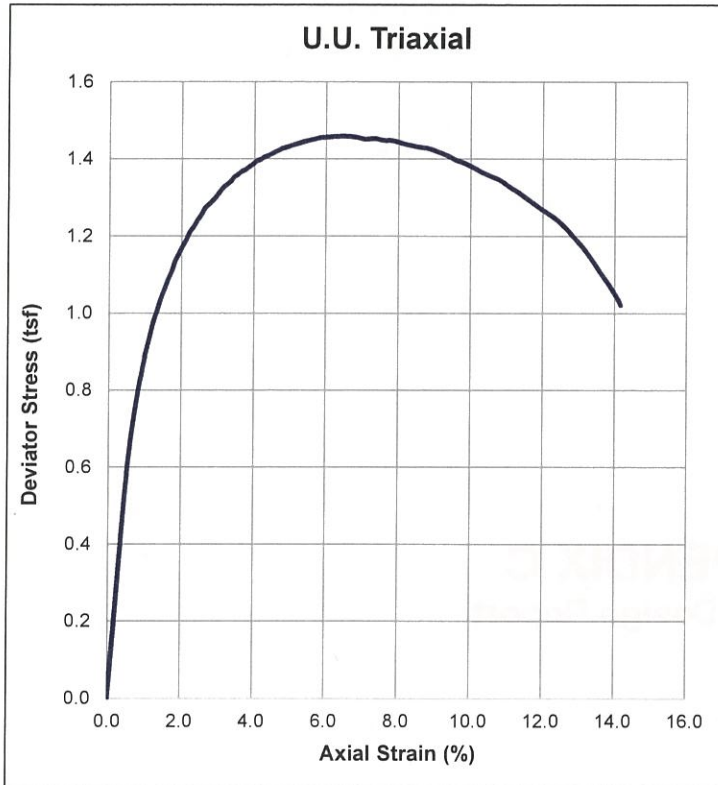
ETTL Engineers & Consultants Inc.

GEOTECHNICAL * MATERIALS * ENVIRONMENTAL * DRILLING * LANDFILLS

ASTM D 2850 Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

Project: Lake Tawakoni Holiday Marina
 Client: Steve Hobbs, P.E.
 Location: Wills Point, TX
 Material: Lt Brown and Lt Gray with Orangish Brown Fat Clay, (CH)

ETTL Project No.: G 5378-20
 Boring No.: B-2
 Sample No. / Depth (ft.): 5.0'-7.0'
 Specimen Trimming ID: E (whole)
 Height: 6.194 inches
 Diameter: 2.639 inches
 Height / Diameter Ratio: 2.35
Initial Moisture Content: 30.2% (trimmings)
Initial Dry Unit Weight: 94.4 lbs./ft³
 Initial Total Unit Weight: 122.8 lbs./ft³
 Specific Gravity: 2.670 (assumed)
 Initial Void Ratio: 0.766
 Initial Saturation: 100.0 %
 Pocket Penetrometer: 2.25 tsf
 Hand Torvane: N/T tsf
 Rate of Strain: 1.0 %/min
Chamber Pressure: 4.7 psi
Peak Strain: 6.6 %
Cor. Maximum Deviator Stress: 1.46 tsf
 Cor. Maximum Deviator Stress: 2918 psf
 Cor. Maximum Deviator Stress: 20.3 psi
 Cor. Secant Modulus at 1/2 Peak Stress: 2.11E+05 psf
 Strain at 50% Max Stress (e₅₀): 6.92E-03 in/in
 Initial Tangent Modulus: 2.88E+05 psf
 Atterbergs LL / PI: 59 | 44
 Passing No. 200 Sieve: 91.0 %
 Sampling Method: 2.8 in. Shelby Tube
 Type of Specimen: Undisturbed
 Date Sampled: 3/2/2020



Membrane Correction Factor Applied to Deviator Stress (tsf) = 0.028

This test has been run to a maximum % strain of: 14.2

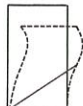
Measured Angle of Fracture from Horizontal: 45

Remarks:

Sketch of Fracture:

Technician: Tommy Burns Test Date: 3/7/2020

Report Date: 3/11/2020



Bulge

APPENDIX C
Seismic Design Report



Latitude, Longitude: 32.80937311, -95.92711652



Date	3/13/2020, 8:40:36 AM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	D - Stiff Soil

Type	Value	Description
S _S	0.102	MCE _R ground motion. (for 0.2 second period)
S ₁	0.059	MCE _R ground motion. (for 1.0s period)
S _{MS}	0.163	Site-modified spectral acceleration value
S _{M1}	0.142	Site-modified spectral acceleration value
S _{DS}	0.109	Numeric seismic design value at 0.2 second SA
S _{D1}	0.094	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	B	Seismic design category
F _a	1.6	Site amplification factor at 0.2 second
F _v	2.4	Site amplification factor at 1.0 second
PGA	0.049	MCE _G peak ground acceleration
F _{PGA}	1.6	Site amplification factor at PGA
PGA _M	0.078	Site modified peak ground acceleration
T _L	12	Long-period transition period in seconds
S _{sRT}	0.102	Probabilistic risk-targeted ground motion. (0.2 second)
S _{sUH}	0.108	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
S _{sD}	1.5	Factored deterministic acceleration value. (0.2 second)
S _{1RT}	0.059	Probabilistic risk-targeted ground motion. (1.0 second)
S _{1UH}	0.066	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S _{1D}	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
C _{RS}	0.945	Mapped value of the risk coefficient at short periods
C _{R1}	0.893	Mapped value of the risk coefficient at a period of 1 s

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SECTION 01 2100 - ALLOWANCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements governing allowances.
- B. Types of allowances include the following:
 - 1. Lump-sum allowances.
- C. Related Requirements:
 - 1. Section 01 2600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.

1.3 DEFINITIONS

- A. Allowance: A quantity of work or dollar amount included in the Contract, established in lieu of additional requirements, used to defer selection of actual materials and equipment to a later date when direction will be provided to Contractor. If necessary, additional requirements will be issued by Change Order.

1.4 SELECTION AND PURCHASE

- A. At the earliest practical date after award of the Contract, advise Architect of the date when final selection, or purchase and delivery, of each product or system described by an allowance must be completed by the Owner to avoid delaying the Work.
- B. At Architect's request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by Architect from the designated supplier.

1.5 ACTION SUBMITTALS

- A. Submit proposals for purchase of products or systems included in allowances in the form specified for Change Orders.

1.6 INFORMATIONAL SUBMITTALS

- A. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- B. Submit time sheets and other documentation to show labor time and cost for installation of allowance items that include installation as part of the allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.7 LUMP-SUM ALLOWANCES

- A. Allowance shall include cost to Contractor of specific products and materials ordered by Owner or selected by Architect under allowance and shall include freight, and delivery to Project site.
- B. Unless otherwise indicated, Contractor's costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by Owner or selected by Architect under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. Unused Materials: Return unused materials purchased under an allowance to manufacturer or supplier for credit to Owner, after installation has been completed and accepted.
 - 1. If requested by Architect, retain and prepare unused material for storage by Owner. Deliver unused material to Owner's storage space as directed.

1.8 ADJUSTMENT OF ALLOWANCES

- A. Allowance Adjustment: To adjust allowance amounts, prepare a Change Order proposal based on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place where applicable. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, required maintenance materials, and similar margins.
 - 1. Include installation costs in purchase amount only where indicated as part of the allowance.
 - 2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other markups.
 - 3. Owner reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.
- B. Submit claims for increased costs due to a change in the scope or nature of the allowance described in the Contract Documents, whether for the purchase order amount or Contractor's handling, labor, installation, overhead, and profit.
 - 1. Do not include Contractor's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of Work has changed from what could have been foreseen from information in the Contract Documents.

2. No change to Contractor's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 SCHEDULE OF ALLOWANCES

- A. Allowance No. 1: Lump-Sum Allowance: Include the sum of \$1,500.00 for code required signage, as specified in Section 10 1423 "Panel Signage."
 1. This allowance includes material, receiving, handling, and installation costs, and Contractor overhead and profit.
- B. Allowance No. 2: Lump-Sum Allowance: Include the sum of \$2,500.00 for access doors and frames, as specified in Section 08 3113 "Access Doors and Frames."
 1. This allowance includes material, receiving, handling, and installation costs, and Contractor overhead and profit.

END OF SECTION 01 2100

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Structural Slab.
 - 4. Suspended slabs.
 - 5. Concrete toppings.
 - 6. Building frame members.
 - 7. Building walls.
- B. Related Sections include the following:
 - 1. Division 00 Section "Geotechnical Data" for soil fill under slabs-on-grade.
 - 2. Division 01 Section "Quality Requirements."

1.2 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.
- E. Samples: For waterstops and vapor retarder.
- F. Welding certificates.
- G. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- H. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Fiber reinforcement.
 - 6. Waterstops.
 - 7. Curing compounds.
 - 8. Floor and slab treatments.
 - 9. Bonding agents.
 - 10. Adhesives.
 - 11. Vapor retarders.
 - 12. Semirigid joint filler.
 - 13. Joint-filler strips.
 - 14. Repair materials.
- I. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.
- J. Field quality-control test and inspection reports.
- K. Minutes of preinstallation conference.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Testing Agency Qualifications: An independent agency acceptable to authorities having jurisdiction qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code-Reinforcing Steel."
- F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
1. ACI 301, "Specification for Structural Concrete".
 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- H. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship, if requested by Architect/Owner.
1. Approved panels may become part of the completed Work if undisturbed at time of Substantial Completion.
- I. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.

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

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

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 Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 2. Products: Subject to compliance with requirements, provide one of the products specified.
 3. 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.
 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 1. Plywood, metal, or other approved panel materials.
 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1 or better.
 - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
 - c. Structural 1, B-B or better; mill oiled and edge sealed.

- d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
- D. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- E. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- H. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed bars, ASTM A 767/A 767M, Class I zinc coated after fabrication and bending.
- D. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed bars, ASTM A 775/A 775M epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.
- E. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 deformed bars, assembled with clips.

- F. Plain-Steel Wire: ASTM A 82, as drawn.
- G. Deformed-Steel Wire: ASTM A 496.
- H. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.
- I. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- J. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from galvanized steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, ASTM A 775/A 775M epoxy coated.
- C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
- D. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
 - 3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.5 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I/II gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

- B. Normal-Weight Aggregates: ASTM C 33, Class [3S] [3M] [1N] coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
 - 1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Lightweight Aggregate: ASTM C 330, 1-inch nominal maximum aggregate size.
- D. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.
 - 1. Available Products:
 - a. Boral Material Technologies, Inc.; Boral BCN.
 - b. Euclid Chemical Company (The); Eucon CIA.
 - c. Grace Construction Products, W. R. Grace & Co.; DCI.
 - d. Master Builders, Inc.; Rheocrete CNI.
 - e. Sika Corporation; Sika CNI.
- D. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable,[free of carbon black,] nonfading, and resistant to lime and other alkalis.
 - 1. Available Manufacturers:
 - a. Bayer Corporation.
 - b. ChemMasters.
 - c. Conspec Marketing & Manufacturing Co., Inc.; a Dayton Superior Company.

- d. Davis Colors.
- e. Elementis Pigments, Inc.
- f. Hoover Color Corporation.
- g. Lambert Corporation.
- h. Scofield, L. M. Company.
- i. Solomon Colors.

- 2. Color: As selected by Architect from manufacturer's full range.

2.7 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Available Manufacturers:
 - a. Greenstreak.
 - b. Progress Unlimited, Inc.
 - c. Williams Products, Inc.
 - B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.
 - 1. Available Products:
 - a. JP Specialties, Inc.; Earth Shield TPE-Rubber.
 - b. Vinylex Corp.; PetroStop.
 - c. WESTEC Barrier Technologies, Inc.; 600 Series TPE-R.
 - C. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Available Manufacturers:
 - a. Bometals, Inc.
 - b. Greenstreak.
 - c. Meadows, W. R., Inc.
 - d. Murphy, Paul Plastics Co.
 - e. Progress Unlimited, Inc.
 - f. Tamms Industries, Inc.
 - g. Vinylex Corp.
 - D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Available Products:
 - a. Colloid Environmental Technologies Company; Volclay Waterstop-RX.
 - b. Concrete Sealants Inc.; Conseal CS-231.
 - c. Greenstreak; Swellstop.
 - d. Henry Company, Sealants Division; Hydro-Flex.
 - e. JP Specialties, Inc.; Earthshield Type 20.
 - f. Progress Unlimited, Inc.; Superstop.
 - g. TCMiraDRI; Mirastop.

2.8 VAPOR RETARDERS

- A. Plastic Vapor Retarder: ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Available Products:
 - a. Fortifiber Corporation; Moistop Ultra.
 - b. Raven Industries Inc.; Vapor Block 10.
 - c. Stego Industries, LLC; Stego Wrap, 10 mils.

2.9 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Available Products:
 - a. Axim Concrete Technologies; Cimfilm.
 - b. Burke by Edoco; BurkeFilm.
 - c. ChemMasters; Spray-Film.
 - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
 - e. Dayton Superior Corporation; Sure Film.
 - f. Euclid Chemical Company (The); Eucobar.
 - g. Kaufman Products, Inc.; Vapor Aid.
 - h. Lambert Corporation; Lambco Skin.
 - i. L&M Construction Chemicals, Inc.; E-Con.
 - j. MBT Protection and Repair, Div. of ChemRex; Confilm.
 - k. Meadows, W. R., Inc.; Sealtight Evapre.
 - l. Metalcrete Industries; Waterhold.
 - m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
 - n. Sika Corporation, Inc.; SikaFilm.
 - o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
 - p. Unitex; Pro-Film.
 - q. US Mix Products Company; US Spec Monofilm ER.
 - r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
 - 1. Available Products:
 - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
 - b. Burke by Edoco; Aqua Resin Cure.
 - c. ChemMasters; Safe-Cure Clear.
 - d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; W.B. Resin Cure.
 - e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
 - f. Euclid Chemical Company (The); Kurez DR VOX.
 - g. Kaufman Products, Inc.; Thinfilm 420.
 - h. Lambert Corporation; Aqua Kure-Clear.
 - i. L&M Construction Chemicals, Inc.; L&M Cure R.
 - j. Meadows, W. R., Inc.; 1100 Clear.
 - k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
 - l. Symons Corporation, a Dayton Superior Company; Resi-Chem Clear Cure.
 - m. Tamms Industries, Inc.; Horncure WB 30.
 - n. Unitex; Hydro Cure 309.
 - o. US Mix Products Company; US Spec Maxcure Resin Clear.
 - p. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.
- F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
 - 1. Available Products:
 - a. Burke by Edoco; Cureseal 1315 WB.
 - b. ChemMasters; Polyseal WB.
 - c. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Sealcure 1315 WB.
 - d. Euclid Chemical Company (The); Super Diamond Clear VOX.
 - e. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
 - f. Lambert Corporation; UV Safe Seal.
 - g. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - h. Meadows, W. R., Inc.; Vocomp-30.
 - i. Metalcrete Industries; Metcure 30.
 - j. Symons Corporation, a Dayton Superior Company; Cure & Seal 31 Percent E.
 - k. Tamms Industries, Inc.; LusterSeal WB 300.
 - l. Unitex; Hydro Seal 25.
 - m. US Mix Products Company; US Spec Radiance UV-25.
 - n. Vexcon Chemicals, Inc.; Vexcon Starseal 1315.

2.10 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Reglets: 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.
- F. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.11 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
 - 4. Compressive Strength: Not less than 4100 psiat 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.

4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.12 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 1. Fly Ash: 25 percent.
 2. Combined Fly Ash and Pozzolan: 25 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
 1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
- E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.13 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings: Proportion normal-weight concrete mixture as follows:
 1. Minimum Compressive Strength: 3000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.55.
 3. Slump Limit: 5 inches, plus or minus 1 inch.
- B. Foundation Walls: Proportion normal-weight concrete mixture as follows:
 1. Minimum Compressive Strength: 3000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.55.
 3. Slump Limit: 4 inches, plus or minus 1 inch.

4. Air Content: 4 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
- C. Structural Slab: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi at 28 days.
 2. Minimum Cementitious Materials Content: 517 lb/cu. yd..
 3. Slump Limit: 4 inches or minus 1 inch.
 4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.
- D. Suspended Slabs: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 3500 psi at 28 days.
 2. Minimum Cementitious Materials Content: 517 lb/cu. yd..
 3. Slump Limit: 4 inches, plus or minus 1 inch.
 4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.
- E. Suspended Slabs: Proportion structural lightweight concrete mixture as follows:
1. Minimum Compressive Strength: 3500 psi at 28 days.
 2. Calculated Equilibrium Unit Weight: 115 lb/cu. ft., plus or minus 3 lb/cu. ft. as determined by ASTM C 567.
 3. Slump Limit: 4 inches, plus or minus 1 inch.
 4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent.
- F. Building Frame Members: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.50.
 3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
 4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
- G. Building Walls: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.50.
 3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
 4. Air Content: 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

2.14 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.15 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 - 1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
 - 2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
 - 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces.
 - 2. Class B, 1/4 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
 - 3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

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

- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
 - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

- A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
 - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.
- B. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.

3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
 - 1. Weld reinforcing bars according to AWS D1.4, where indicated.

- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.
- G. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

- D. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOPS

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- G. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish, to be covered with a coating or covering material applied directly to concrete.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform

- color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in 1 direction.
 1. Apply scratch finish to surfaces indicated and to receive concrete floor toppings.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
 1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 1. Apply a trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:

- a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
 - b. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- G. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
 2. After broadcasting and tamping, apply float finish.
 3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

3.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project..
 - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

- a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least three months. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.16 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:

1. Steel reinforcement placement.
 2. Steel reinforcement welding.
 3. Headed bolts and studs.
 4. Verification of use of required design mixture.
 5. Concrete placement, including conveying and depositing.
 6. Curing procedures and maintenance of curing temperature.
 7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, 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 mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 5. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 6. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
 7. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive

- strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
10. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 11. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 12. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
 13. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 14. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- D. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

END OF SECTION 03 30 00

SECTION 04 20 00 - UNIT MASONRY

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. Concrete block.
- B. Clay brick.
- C. Mortar and grout.
- D. Reinforcement and anchorage.
- E. Accessories.

1.3 RELATED REQUIREMENTS

- A. Section 05 50 00 - Metal Fabrications: Fabricated steel items.
- B. Section 07 92 00 - Joint Sealants: Sealing control and expansion joints.

1.4 REFERENCE STANDARDS

- A. ACI 315 - Details and Detailing of Concrete Reinforcement.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- C. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- D. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement.
- E. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- F. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.
- G. ASTM C126 - Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.
- H. ASTM C140/C140M - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

- I. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
- J. ASTM C150/C150M - Standard Specification for Portland Cement.
- K. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
- L. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made From Clay or Shale).
- M. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
- N. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
- O. ASTM C476 - Standard Specification for Grout for Masonry.
- P. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
- Q. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry.
- R. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing.
- S. BIA Technical Notes No. 13 - Ceramic Glazed Brick Exterior Walls.
- T. BIA Technical Notes No. 28B - Brick Veneer/Steel Stud Walls.
- U. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures.

1.5 **ADMINISTRATIVE REQUIREMENTS**

- A. Coordination: Direct and coordinate placement of metal anchors supplied for installation under other Sections.
- B. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all relevant installers.
 - 1. Convene under general provisions of Section .
 - 2. Require attendance by all relevant installers.
 - 3. Review conditions of installation, installation procedures, and coordination with related work.

1.6 **SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.

- C. Shop Drawings: Submit drawings indicating steel reinforcing in compliance with ACI 315.
 - 1. Indicate bar sizes, spacing, locations, and quantities of reinforcing steel, bending and cutting schedules, and supporting and spacing devices.
- D. Samples: Submit two samples of each type of masonry unit and pigmented mortar to illustrate color, texture, and extremes of color range.
- E. Samples: Submit samples of all masonry accessories.
- F. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
 - 1. Include material test reports substantiating compliance with requirements.
 - 2. For exposed brick, include test report for efflorescence according to ASTM C 67.
 - 3. For masonry units, include data and calculations establishing average net-area compressive strength of units.
- G. Manufacturer's Qualification Statement.
- H. Installer's Qualification Statement.

1.7 **QUALITY ASSURANCE**

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
 - 1. Maintain one copy of each document on project site.
- B. Designer Qualifications: Perform design under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in Texas.
- C. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum three years of documented experience.
- D. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.8 **MOCK-UP**

- A. Comply with general mock-up requirements specified in Section 01 40 00.
- B. Mock-up: Construct a stand-alone masonry wall as a mock-up panel sized 8 feet long by 6 feet high; include mortar and accessories in mock-up.
 - 1. Locate where directed.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
- B. Handle and store ceramic glazed masonry units in protective cartons or trays. Do not remove from protective packaging until ready for installation.

1.10 FIELD CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 PRODUCTS

2.1 CONCRETE MASONRY UNITS (CMU)

- A. Concrete Block: Comply with referenced standards and as follows:
 - 1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depths as indicated on the Drawings for specific locations.
 - 2. Special Shapes: Provide non-standard blocks configured for corners, lintels, headers, control joint edges, and other detailed conditions.
 - a. Provide bullnose units for outside corners.
 - b. Provide matching solid units for use at ends of soldier and sill courses.
 - 3. Load-Bearing Units: ASTM C90, normal weight.
 - a. Hollow blocks indicated
 - b. Unit Compressive Strength: 1,900 psi, average net area, minimum.

2.2 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I.
 - 1. Not more than 0.60 percent alkali.
 - 2. Hydrated Lime: ASTM C207, Type S.
 - 3. Mortar Aggregate: ASTM C144.

4. Grout Aggregate: ASTM C404.
- B. Water: Clean and potable.
- C. Admixtures: Not permitted unless specified, or requested by Contractor in writing and approved in writing by Architect.
- D. Air-Entraining Admixture: Limit entrained air to maximum 12 percent.
- E. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
 1. Color: Mineral pigments added as required to produce approved color sample.
- F. Packaged Dry Material for Grout for Masonry: Premixed cementitious materials and dried aggregates; capable of producing grout of the specified strength in accordance with ASTM C476 with the addition of water only.
 1. Type: Fine.

2.3 REINFORCEMENT AND ANCHORAGE

- A. Acceptable Manufacturers:
 1. Blok-Lok Limited: www.blok-lok.com.
 2. Hohmann & Barnard, Inc.: www.h-b.com/sle.
 3. WIRE-BOND www.wirebond.com/#sle.
- B. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi), deformed billet bars; uncoated.
- C. Single Wythe Joint Reinforcement: ASTM A951/A951M.
 1. Type: Ladder.
 2. Material: ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to 16 CFR 1201 Class B.
 3. Size: 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not less than 5/8 inch of mortar coverage on each exposure.
 4. Hoffmann & Barnard Tie-2R.
- D. Strap Anchors: Bent steel shapes configured as required for specific situations, 1-1/4 in width, 0.105 in thick, lengths as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A153/A153M Class B.

- E. Residential Wall Ties: Corrugated formed sheet metal, 7/8 inch wide by 0.05 inch thick, hot dip galvanized to ASTM A 153/A 153M, Class B, sized to extend at least 1-1/2 inches into the veneer with at least 5/8 inch of mortar coverage from masonry face.
- F. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A153/A153M Class B.
 - 1. Anchor Plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
 - 2. Wire Ties: Triangular shape, 0.1875 inch thick.
 - 3. Vertical Adjustment: Not less than 3-1/2 inches.

2.4 FLASHINGS

- A. Sheet Metal Flashings:
 - 1. Prefabricated Metal Flashing: Smooth fabricated 28 ga stainless steel (type 304) flashing for thru-wall conditions.
 - 2. Factory-Fabricated Flashing Corners and End Dams: Stainless steel.
- B. Flashing Sealant/Adhesives: Non-curing butyl or other type required or recommended by flashing manufacturer and capable of adhering to type of flashing used.
- C. Termination Bars: Stainless steel; compatible with membrane and adhesives.
- D. Drip Edge: Stainless steel; angled drip with hemmed edge; compatible with membrane and adhesives.
- E. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membranes and adhesives.

2.5 ACCESSORIES

- A. Preformed Control Joints: Rubber or neoprene material. Provide with corner and tee accessories, fused joints.
- B. Joint Filler: Closed cell rubber, neoprene or urethane; oversized 50 percent to joint width; self expanding; in maximum lengths available.
 - 1. Complying with ASTM D 1056, Grade 2A1.
 - 2. Acceptable Manufacturers:
 - a. Hohmann & Barnard, Inc.: www.h-b.com/sle.
 - b. WIRE-BOND: www.wirebond.com/#sle.

- C. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
 - 1. Mortar Diverter: Semi-rigid mesh designed for installation at flashing locations.
 - a. Acceptable Manufacturers:
 - 1) Advanced Building Products Inc.; Mortar Break
DT: www.advancedbuildingproducts.com/sle.
 - 2) Mortar Net Solutions; MortarNet: www.mortarnet.com/#sle.
 - 3) York Manufacturing, Inc; Weep-Net: www.yorkmfg.com/#sle.
 - 4) Hohmann & Barnard, Inc.; Mortar Trap: www.h-b.com.
 - D. Weeps: Molded PVC grilles, insect resistant.
 - 1. Width: Match specified mortar joint thickness; 3/8 inch, unless otherwise indicated.
 - 2. Height: Match height of applicable masonry unit.
 - 3. Depth: Match depth of applicable masonry unit.
 - 4. Color(s): As selected by Architect from manufacturer's full range.
 - 5. Acceptable Manufacturers:
 - a. Advanced Building Products, Inc; Mortar Maze Cell
Vent: www.advancedbuildingproducts.com/#sle.
 - b. Blok-Lok Limited; CELLVENT: www.blok-lok.com/#sle.
 - c. Hohmann & Barnard, Inc.; QV Quadro-Vent: www.h-b.com.
 - d. Mortar Net Solutions; CellVent: www.mortarnet.com/#sle.
 - e. WIRE-BOND; Cell Vent: www.wirebond.com/#sle.
 - E. Sealants: Types required by flashing manufacturer to suit indicated installation and service conditions.
 - F. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.
- 2.6 **LINTELS**
- A. Steel Lintels: Specified in Section 05 50 00.

- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.7 MORTAR AND GROUT MIXES

- A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
 - 1. Masonry Below Grade in Contact With Earth: Type M.
 - 2. Exterior Loadbearing Masonry: Type S.
 - 3. Exterior Non-loadbearing Masonry: Type S.
 - 4. Interior Loadbearing Masonry: Type S.
 - 5. Interior Non-loadbearing Masonry: Type S.
- B. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.
- C. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.
- D. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other Sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.
- D. At masonry veneer installations, verify that air barrier is installed according to Section 07 27 13.

3.2 PREPARATION

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

3.3 COLD AND HOT WEATHER REQUIREMENTS

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

3.4 COURSING

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

3.5 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Lay hollow masonry units with face shell bedding on head and bed joints.
- C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- D. Remove excess mortar and mortar smears as work progresses.
- E. Remove excess mortar with water repellent admixture promptly. Do not use acids, sandblasting or high pressure cleaning methods.
- F. Interlock intersections and external corners.
- G. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- H. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
- I. Cut mortar joints flush where wall tile is scheduled or resilient base is scheduled.
- J. Isolate masonry partitions from vertical structural framing members with a control joint as indicated.
- K. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.

3.6 WEEPS/CAVITY VENTS

- A. Install weeps in veneer and cavity walls at maximum 24 inches on center horizontally above through-wall flashing, above shelf angles and lintels, at bottom of walls, and at rowlock/belt courses where indicated.

3.7 CAVITY MORTAR CONTROL

- A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.
- B. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.
- C. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.8 REINFORCEMENT AND ANCHORAGE - GENERAL

- A. Unless otherwise indicated on Drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Embed longitudinal wires of joint reinforcement in mortar joint with at least 5/8 inch mortar cover on each side.
- E. Lap joint reinforcement ends minimum 12 inches.
- F. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches on center.
- G. Embed ties and anchors in mortar joint and extend into masonry unit a minimum of 1-1/2 inches with at least 5/8 inch mortar cover to the outside face of the anchor.

3.9 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

- A. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 16 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

3.10 REINFORCEMENT AND ANCHORAGES - MULTIPLE WYTHE UNIT MASONRY

- A. Use individual metal ties installed in horizontal joints to bond wythes together. Provide ties spaced as indicated on Drawings.
- B. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.

3.11 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.

1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up flashing ends at least 1 inch, minimum, to form watertight pan at non-masonry construction.
 2. Remove or cover protrusions or sharp edges that could puncture flashings.
 3. Seal lapped ends and penetrations of flashing before covering with mortar.
- B. Terminate flashing up 8 inches minimum on vertical surface of backing:
1. Install vertical leg of flashing behind air barrier system. Terminate top of flashing with air barrier manufacturer's standard transition material and lap air barrier over flashing.
- C. Install flashing in accordance with manufacturer's instructions and BIA Technical Notes No. 7.
- D. Extend metal flashings through exterior face of masonry and terminate in an angled drip with hemmed edge. Install joint sealer below drip edge to prevent moisture migration under flashing.
1. Form drips at lower edge of sheet metal counter-flashings (cap flashings), fascias, gravel stops, wall copings, by folding edge back 1/2 inch and bending out 45 degrees from vertical to carry water away from the wall
- E. Where dowels, reinforcing bars and fastening devices penetrate flashing, seal penetration with sealing compound.

3.12 **LINTELS**

- A. Install steel lintels over openings where indicated.
- B. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.
1. Reinforced Lintels: Place reinforcing as indicated on Drawings.
- C. Maintain minimum 8 inch bearing on each side of opening.

3.13 **GROUTED COMPONENTS**

- A. Reinforce bond beams as indicated on Drawings.
- B. Lap splices minimum 24 bar diameters, unless otherwise indicated in drawings.
- C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- D. Place and consolidate grout fill without displacing reinforcing.
- E. Grout solid all hollow concrete unit masonry located below grade, and at other locations indicated.

- F. At bearing locations, fill masonry cores with grout for a minimum 8 inches both sides of opening unless otherwise indicated in drawings.

3.14 CONTROL AND EXPANSION JOINTS

- A. Size control joints as indicated on Drawings; if not shown, 3/8 inch wide.
- B. Do not continue horizontal joint reinforcement through control or expansion joints.
- C. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- D. If control joint locations are not indicated on drawings, locate control joints in CMU walls complying with the NCMA TEK note recommendations and at wall height changes; within ten feet of corners; at wall thickness changes; at bond beam breaks; at abutments of columns and walls; at abutment of cold garages to warm basements or walls; at openings in walls such as doors and windows; and at intervals in continuous walls not exceeding 20 feet in length, unless more restrictive spacing is recommended in the NCMA TEK notes.

3.15 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames, fabricated metal frames, anchor bolts, and plates and other items to be built into the work and furnished under other Sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.16 TOLERANCES

- A. Install masonry within the site tolerances found in TMS 402/602.
- B. Maximum Variation from Alignment of Columns: 1/4 inch.
- C. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- G. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/8 inch, plus 1/8 inch.

- H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.17 CUTTING AND FITTING

- A. Cut and fit for chases, pipes, conduit, sleeves, and grounds. Coordinate with other Sections of work to provide correct size, shape, and location.
- B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.18 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
 - 1. See Structural Drawings for additional requirements.
- B. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140/C140M for conformance to requirements of this specification.
- C. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

3.19 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with specified cleaning solution, at low pressure or by hand methods only; do not introduce excessive moisture into masonry wall surfaces during cleaning operations.
- D. Use non-metallic tools and stiff brushes in cleaning operations.

3.20 PROTECTION

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

A. END OF SECTION

SECTION 04 4313.13 - ANCHORED STONE MASONRY VENEER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Stone masonry anchored to wood framing and sheathing.
- B. Products Installed but Not Furnished under This Section Include:
 - 1. Cast-stone trim in masonry veneer.
 - 2. Steel lintels in unit masonry.
- C. Related Requirements:
 - 1. Section 04 2000 "Unit Masonry" for horizontal joint reinforcement and veneer anchors for unit masonry backup.

1.3 ACTION SUBMITTALS

- A. Product Data: For each variety of stone, stone accessory, and manufactured product.
- B. Samples for Verification:
 - 1. For each stone type indicated. Include at least three Samples in each set and show the full range of color and other visual characteristics in completed Work.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Material Test Reports:
 - 1. Stone Test Reports: For each stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous five years.
 - 2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.
- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.7 FIELD CONDITIONS

- A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
 - 1. Extend cover a minimum of **24 inches (600 mm)** down both sides and hold cover securely in place.
- B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.
 - 1. Protect base of walls from rain-splashed mud and mortar splatter using coverings spread on the ground and over the wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at end of each day to prevent rain from splashing mortar and dirt on completed stone masonry.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and above and will remain so until masonry has dried, but not less than seven days after completing cleaning.

- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

1.8 COORDINATION

- A. Advise installers of adjacent Work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone masonry.
- B. Coordinate locations of dovetail slots installed in concrete that are to receive stone anchors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Stone: Obtain stone from single quarry with resources to provide materials of consistent quality in appearance and physical properties.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.
- A. Varieties and Sources: Subject to compliance with requirements, provide Custom Blend of "Hickory Veneer" and "Buff Lueders Chopped Veneer" as supplied by Texas Custom Stoneworks, Winnsboro, TX, (903) 342-3333. Stone blend and installation pattern to match Tournament Pavilion on site under separate contract.

2.2 MORTAR MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction; natural color or white cement may be used as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
 - 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Holcim \(US\) Inc; LafargeHolcim](#); Rainbow Mortamix Custom Color Cement/Lime.
 - b. [Lafarge North America Inc.;](#) Eaglebond.
 - c. [Lehigh Hanson; HeidelbergCement Group](#); Lehigh Custom Color Portland/Lime Cement.
- D. Aggregate: ASTM C144 and as follows:

1. For pointing mortar, use aggregate graded with 100 percent passing **No. 16 (1.18-mm)** sieve.
 2. White Aggregates: Natural white sand or ground white stone.
- E. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. **Euclid Chemical Company (The); an RPM company;** Accelguard 80.
 - b. **GCP Applied Technologies Inc.;** Morset.
 - c. **Sonneborn;** Trimix-NCA.
- F. Water: Potable.

2.3 VENEER ANCHORS

- A. Materials:
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A1064/A1064M; with ASTM A153/A153M, Class B-2.
 2. Stainless Steel Wire: ASTM A580/A580M, Type 304.
 3. Hot-Dip Galvanized-Steel Sheet: ASTM A1008/A1008M, cold-rolled, carbon-steel sheet, hot-dip galvanized after fabrication to comply with ASTM A153/A153M, Class B-2.
- B. Size: Sufficient to extend at least halfway, but not less than **1-1/2 inches (38 mm)**, through stone masonry and with at least a **5/8-inch (16-mm)** cover on exterior face.
- C. Adjustable Masonry-Veneer Anchors for wood framing and sheathing:
1. General: Provide anchors that allow vertical adjustment but resist a **100-lbf (445-N)** load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of **1/16 inch (1.5 mm)**.
 2. Fabricate wire ties from **0.187-inch- (4.76-mm-)** diameter, hot-dip galvanized-steel wire unless otherwise indicated.
 3. Fabricate wire connector sections from **0.187-inch- (4.76-mm-)** diameter, hot-dip galvanized-steel wire.

2.4 STONE TRIM ANCHORS

- A. Stone Trim Anchors: Units fabricated with tabs or dowels designed to engage kerfs or holes in stone trim units and holes for fasteners or postinstalled anchor bolts for fastening to substrates or framing as indicated.
1. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. [Canaren Inc.](#)
 - b. [Heckmann Building Products, Inc.](#)
 - c. [Hohmann & Barnard, Inc.](#)
 - d. [Meadow Burke.](#)
- B. Materials: Fabricate anchors from stainless steel, ASTM A240/A240M or ASTM A666, Type 304. Fabricate dowels from stainless steel, ASTM A276, Type 304.
- C. Fasteners for Stone Trim Anchors: Annealed stainless steel bolts, nuts, and washers; **ASTM F593 (ASTM F738M)** for bolts and **ASTM F594 (ASTM F836M)** for nuts, **Alloy Group 1 (A1)**.
- D. Postinstalled Anchor Bolts for Fastening Stone Trim Anchors: Chemical anchors, torque-controlled expansion anchors, or undercut anchors made from stainless steel components complying with **ASTM F593 and ASTM F594, Alloy Group 1 or 2 (ASTM F738M and ASTM F836M, Alloy Group A1 or A4)** for bolts and nuts; ASTM A666 or ASTM A276, Type 304 or Type 316, for anchors.

2.5 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Stainless Steel: ASTM A240/A240M, Type 304, **0.016 inch (0.4 mm)** thick.
 2. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself **3/4 inch (19 mm)** at exterior wall face and down into joint **3/8 inch (10 mm)** to form a stop for retaining sealant backer rod.
 3. Metal Sealant Stops: Fabricate from stainless steel. Extend at least **3 inches (75 mm)** into wall and out to exterior wall face. At exterior wall face, bend metal back on itself for **3/4 inch (19 mm)** and down into joint **3/8 inch (10 mm)** to form a stop for retaining sealant backer rod.
- B. Flexible Flashing: For flashing unexposed to the exterior, use the following unless otherwise indicated:
1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive, rubberized-asphalt compound, bonded to a high-density, cross-laminated, polyethylene film to produce an overall thickness of not less than **0.030 inch (0.76 mm)**.
 - 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) [Advanced Building Products Inc.](#)
 - 2) [Heckmann Building Products, Inc.](#)
 - 3) [Hohmann & Barnard, Inc.](#)
 - 4) [Wire-Bond.](#)
- C. Application: Unless otherwise indicated, use the following:
1. Where flashing is indicated to receive counterflashing, use metal flashing.

2. Where flashing is indicated to be turned down at or beyond wall face, use metal flashing.
 3. Where flashing is partly exposed and is indicated to terminate at wall face, use metal flashing with a sealant stop.
 4. Where flashing is fully concealed, use flexible flashing.
- D. Solder and Sealants for Sheet Metal Flashings: As specified in Section 07 6200 "Sheet Metal Flashing and Trim."
1. Solder for Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
 2. Elastomeric Sealant: ASTM C920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Adhesives, Primers, and Seam Tapes for Flexible Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Weep/Vent Products: Use the following unless otherwise indicated:
1. Round Plastic Tubing: Medium-density polyethylene, **3/8-inch (10-mm)** OD by thickness of stone masonry.
- C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
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. [Advanced Building Products Inc.](#)
 - b. [CavClear/Archovations, Inc.](#)
 - c. [Mortar Net Solutions.](#)
 2. Provide one of the following configurations:
 - a. Strips, full depth of cavity and **10 inches (250 mm)** wide, with dovetail-shaped notches **7 inches (175 mm)** deep that prevent mesh from being clogged with mortar droppings.

2.7 FABRICATION

- A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.
- B. Split stone to produce pieces of thickness, size, and shape indicated, including details on Drawings and pattern specified in "Setting Stone Masonry" Article.

1. Shape stone specified to be laid in three-course, random range ashlar pattern with split beds.
- C. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.
- D. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
 1. Clean sawed backs of stone to remove rust stains and iron particles.
- E. Thickness of Stone: Provide thickness indicated, but not less than the following:
 1. Thickness: **4 inches (100 mm)** plus or minus **1/4 inch (6 mm)**. Thickness does not include projection of pitched faces.
- F. Finish exposed stone faces and edges to comply with requirements indicated for finish and to match approved samples.
 1. Finish: Rock face (pitched face).

2.8 MORTAR MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 1. Do not use calcium chloride.
 2. Use portland cement-lime mortar unless otherwise indicated.
 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
 4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches required consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Stone Masonry: Comply with ASTM C270, Property Specification.
 1. Mortar for Setting Stone: Type N.
 2. Mortar for Pointing Stone: Type N.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone masonry.
- B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into stone masonry are correctly installed.
- C. Examine wall framing, sheathing, and weather-resistant sheathing paper to verify that stud locations are suitable for spacing of veneer anchors and that installation will result in a weatherproof covering.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Accurately mark stud centerlines on face of weather-resistant sheathing paper before beginning stone installation.
- B. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 INSTALLATION OF STONE MASONRY

- A. Perform necessary field cutting and trimming as stone is set.
 - 1. Pitch face at field-split edges as needed to match stones that are not field split.
- B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- C. Arrange stones in three-course, random-range ashlar pattern with random course heights, random lengths (interrupted coursed), and uniform joint widths.
- D. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
- E. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place.

- F. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
- G. Install steel lintels where indicated. Provide minimum bearing of **8 inches (200 mm)** at each jamb unless otherwise indicated.
- H. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than **1/4 inch (6 mm)** at narrowest points or more than **3/8 inch (10 mm)** at widest points.
- I. Set cast-stone trim units in full bed of mortar with full vertical joints.
 - 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
 - 2. Wet joint surfaces thoroughly before applying mortar.
 - 3. Rake out mortar joints for pointing with sealant.
- J. Provide sealant joints of widths and at locations indicated.
 - 1. Keep sealant joints free of mortar and other rigid materials.
 - 2. Sealant joints are specified in Section 07 9200 "Joint Sealants."
- K. Install embedded flashing and weep holes at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
 - 1. At stud-framed walls, extend flashing through stone masonry, up sheathing face at least **8 inches (200 mm)**, and behind weather barrier.
 - 2. At lintels and shelf angles, extend flashing full length of angles but not less than **6 inches (150 mm)** into masonry at each end.
 - 3. At sills, extend flashing not less than **4 inches (100 mm)** at ends.
 - 4. At ends of head and sill flashing, turn up not less than **2 inches (50 mm)** to form end dams.
 - 5. Extend sheet metal flashing **1/2 inch (13 mm)** beyond masonry face at exterior, and turn flashing down to form a drip.
 - 6. Cut flexible flashing flush with wall face after completing masonry wall construction.
- L. Place weep holes and vents in joints where moisture may accumulate, including at base of cavity walls, above shelf angles, and at flashing.
 - 1. Use round plastic tubing to form weep holes.
 - 2. Space weep holes formed from plastic tubing **16 inches (400 mm)** o.c.
 - 3. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

3.4 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces, do not exceed **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (10 mm in 6 m)**, or **1/2 inch in 40 feet (13 mm in 12 m)** or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed **1/4 inch in 20 feet (6 mm in 6 m)** or **1/2 inch in 40 feet (13 mm in 12 m)** or more.

- B. Variation from Level: For bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines, do not exceed **1/4 inch in 20 feet (6 mm in 6 m)** or **1/2 inch in 40 feet (13 mm in 12 m)** or more.
- C. Variation of Linear Building Line: For position shown in plan, do not exceed **1/2 inch in 20 feet (13 mm in 6 m)** or **3/4 inch in 40 feet (19 mm in 12 m)** or more.
- D. Measure variation from level, plumb, and position shown in plan as a variation of the average plane of each stone face from level, plumb, or dimensioned plane.
- E. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
- F. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

3.5 INSTALLATION OF ANCHORED STONE MASONRY

- A. Anchor stone masonry to wood-stud framing with wire anchors unless otherwise indicated. Fasten anchors through sheathing to wood studs with corrosion-resistant roofing nails.
- B. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than **1-1/2 inches (38 mm)**, through stone masonry and with at least a **5/8-inch (16-mm)** cover on exterior face.
- C. Space anchors to provide not less than one anchor per **2 sq. ft. (0.2 sq. m)** of wall area. Install additional anchors within **12 inches (300 mm)** of openings, sealant joints, and perimeter at intervals not exceeding **12 inches (300 mm)**.
- D. Anchor stone trim with stone trim anchors where indicated. Install anchors by fastening to substrate and inserting tabs and dowels into kerfs and holes in stone units. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.
- E. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.
- F. Provide **2-inch (50-mm)** cavity between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
 - 1. Slope beds toward cavity to minimize mortar protrusions into cavity.
 - 2. Do not attempt to trowel or remove mortar fins protruding into cavity.
- G. Rake out joints for pointing with mortar to depth of not less than **1/2 inch (13 mm)** before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

3.6 POINTING

- A. Prepare stone-joint surfaces for pointing with mortar by removing dust and mortar particles. Where setting mortar was removed to depths greater than surrounding areas, apply pointing mortar in layers not more than **3/8 inch (10 mm)** deep until a uniform depth is formed.

- B. Point stone joints by placing and compacting pointing mortar in layers of not more than **3/8 inch (10 mm)** deep. Compact each layer thoroughly and allow to it become thumbprint hard before applying next layer.
- C. Tool joints, when pointing mortar is thumbprint hard, with a smooth jointing tool to produce the following joint profile:
 - 1. Joint Profile: Concave.

3.7 ADJUSTING AND CLEANING

- A. Remove and replace stone masonry of the following description:
 - 1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
 - 2. Defective joints.
 - 3. Stone masonry not matching approved samples and mockups.
 - 4. Stone masonry not complying with other requirements indicated.
- B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
 - 3. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20, Revised II, using job-mixed detergent solution.

3.8 EXCESS MATERIALS AND WASTE

- A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.
- B. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than **4 inches (100 mm)** in greatest dimension.
 - 2. Mix masonry waste with at least 2 parts of specified fill material for each part of masonry waste. Fill material is specified in Section 31 2000 "Earth Moving."
 - 3. Do not dispose of masonry waste as fill within **18 inches (450 mm)** of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

Lake Tawakoni Tournament Facility - Restroom,
Hardscape, and Landscape
VAN ZANDT COUNTY, TEXAS
SRA PROJECT NO. 2002

ISSUE FOR BID
September 8, 2022

END OF SECTION 04 4313.13

SECTION 04 7200 - CAST STONE MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Trim units.
 - 2. Accessories.
- B. Related Requirements:
 - 1. Section 04 4313.13 "Anchored Stone Masonry Veneer."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
 - 1. Include building elevations showing layout of units and locations of joints and anchors.
- C. Samples for Initial Selection: For color and texture of cast stone.
- D. Samples for Verification:
 - 1. For each color and texture of cast stone required, 4 inches (100 mm) square in size.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C1364.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer of cast stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by CSI or APA.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery of cast stone with unit masonry work to avoid delaying the Work.
- B. Pack, handle, and ship cast stone units in suitable packs or pallets.
 - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units if required, using dollies with wood supports.
 - 2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.
- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.7 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Comply with cold-weather construction requirements in TMS 602.
 - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements in TMS 602.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Cast Stone: Obtain cast stone units from single source from single manufacturer.

2.2 CAST STONE MATERIALS

- A. General: Comply with ASTM C1364.

- B. Portland Cement: ASTM C150/C150M, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C114. Provide natural color or white cement as required to produce cast stone color indicated.
- C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C33/C33M; gradation and colors as needed to produce required cast stone textures and colors.
- D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C33/C33M, gradation and colors as needed to produce required cast stone textures and colors.
- E. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
- F. Admixtures: Use only admixtures specified or approved in writing by Architect.
 - 1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
 - 2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
 - 3. Air-Entraining Admixture: ASTM C260/C260M. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
 - 4. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 - 5. Water-Reducing, Retarding Admixture: ASTM C494/C494M, Type D.
 - 6. Water-Reducing, Accelerating Admixture: ASTM C494/C494M, Type E.
- G. Reinforcement:
 - 1. Deformed steel bars complying with ASTM A615/A615M, **Grade 40 (Grade 280)**. Use galvanized or epoxy-coated reinforcement when covered with less than **1-1/2 inches (38 mm)** of cast stone material.
 - a. Epoxy Coating: ASTM A775/A775M.
 - b. Galvanized Coating: ASTM A767/A767M.
 - 2. Plain-Steel, Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
 - 3. Galvanized-Steel, Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from galvanized-steel wire into flat sheets.
 - 4. Fiber Reinforcement: ASTM C1116/C1116M.
- H. Embedded Anchors and Other Inserts: Fabricated from stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666, Type 304.

2.3 CAST STONE UNITS

- 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. Advanced Architectural Stone.

2. Cast Stone Commercial Services.
3. Dallas Cast Stone Company.
4. Siteworks, Inc.
5. Stone Castle Industries.

B. Cast Stone Units: Comply with ASTM C1364.

1. Units shall be manufactured using the manufacturer's selected method.
2. Trim units including window sills and items as indicated on Drawings.

C. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
3. Provide drips on projecting elements unless otherwise indicated.

D. Fabrication Tolerances:

1. Variation in Cross Section: Do not vary from indicated dimensions by more than **1/8 inch (3 mm)**.
2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or **1/8 inch (3 mm)**, whichever is greater, but in no case by more than **1/4 inch (6 mm)**.
3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or **1/8 inch (3 mm)**, whichever is greater.
4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than **1/8 inch (3 mm)** on formed surfaces of units and **3/8 inch (10 mm)** on unformed surfaces.

E. Cure Units as Follows:

1. Cure units in enclosed, moist curing room at 95 percent relative humidity and temperature of **100 deg F (38 deg C)** for 12 hours or **70 deg F (21 deg C)** for 16 hours.
2. Keep units damp and continue curing to comply with one of the following:
 - a. No fewer than five days at mean daily temperature of **70 deg F (21 deg C)** or above.
 - b. No fewer than seven days at mean daily temperature of **50 deg F (10 deg C)** or above.

F. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

G. Colors and Textures: match color 100-905B By Stone Castle Industries.

2.4 MORTAR MATERIALS

- A. Provide mortar materials that comply with Section 04 4313.13 "Anchored Stone Masonry Veneer."

2.5 ACCESSORIES

- A. Anchors: Type and size indicated, fabricated from Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666.
- B. Dowels: **1/2-inch- (12-mm-)** diameter round bars, fabricated from Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276/A276M, or ASTM A666.

2.6 MORTAR MIXES

- A. Provide mortar mixes that comply with Section 04 4313.13 "Anchored Stone Masonry Veneer."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SETTING CAST STONE IN MORTAR

- A. Install cast stone units to comply with requirements in Section 04 4313.13 "Anchored Stone Masonry Veneer."

3.3 SETTING ANCHORED CAST STONE WITH SEALANT-FILLED JOINTS

- A. Set cast stone as indicated in TMS 604.
- B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
 - 1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
 - 2. Shim and adjust anchors, supports, and accessories to set cast stone in locations indicated with uniform joints.
- C. Keep cavities open where unfilled space is indicated between back of cast stone units and backup wall; do not fill cavities with mortar or grout.
- D. Fill anchor holes with sealant.
 - 1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

- E. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.
- F. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.
 - 1. Form open joint of width indicated, but not less than **3/8 inch (10 mm)**.
- G. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
- H. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Section 07 9200 "Joint Sealants."

3.4 ADJUSTING AND CLEANING

- A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.
- B. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: comply with requirements in Section 04 4313.13 "Anchored Stone Masonry Veneer.
- D. Final Cleaning: comply with requirements in Section 04 4313.13 "Anchored Stone Masonry Veneer:

END OF SECTION 04 7200

SECTION 05 12 00 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Structural steel.
 - 2. Architecturally exposed structural steel.
 - 3. Prefabricated building columns.
 - 4. Grout.

- B. Related Sections include the following:
 - 1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
 - 2. Division 05 Section "Steel Deck" for field installation of shear connectors.
 - 3. Division 05 Section "Metal Fabrications" for miscellaneous steel fabrications and other metal items not defined as structural steel.
 - 4. Division 09 painting Sections for surface preparation and priming requirements.

1.2 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

- B. Architecturally Exposed Structural Steel: Structural steel designated as architecturally exposed structural steel in the Contract Documents.

1.3 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of all connections required by the Contract Documents to be selected or completed by structural-steel fabricator to withstand ASD-service loads indicated and comply with other information and restrictions indicated.
 - 1. Select and complete connections using schematic details indicated and AISC's "Manual of Steel Construction, Allowable Stress Design," Part 4.
 - 2. Engineering Responsibility: Fabricator's responsibilities include using a qualified professional engineer to prepare structural analysis data for structural-steel connections.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
 - 5. For structural-steel connections indicated to comply with design loads, include structural analysis data prepared by the qualified professional engineer responsible for their preparation.
- C. Welding certificates.
- D. 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. Direct-tension indicators.
 - 4. Tension-control, high-strength bolt-nut-washer assemblies.
 - 5. Shear stud connectors.
 - 6. Shop primers.
 - 7. Nonshrink grout.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CASE. The General Contractor may accept a bid proposal from an erection sub-contractor who specializes in performing the type of work indicated by the construction documents and who has a minimum of 5 years of documented experience. This waiver does not relieve the requirements to perform in accordance with applicable A.I.S.C., S.J.I., S.D.I. & O.S.H.A. regulation. It is the general contractors' responsibility to ascertain that the sub-contractor follows the stated requirements. Neither the owner nor the design team will be responsible for lack of compliance.
- B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant. The General Contractor may accept a bid proposal from a fabricator who has been certified by a local authority (City, County or State) or who can produce an in-plant inspection report from a local testing laboratory. This waiver does not relieve the fabricators' responsibility to perform work in accordance with A.I.S.C., S.J.I., S.D.I. & O.S.H.A. regulations Mill test reports for all supplied steel must be properly secured and all welders must have a current AWS qualification papers. It is the General Contractors' responsibility to ascertain that the sub-contractor meets the stated requirements. Neither the owner nor the design team will be responsible for lack of compliance.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code-Steel."
- E. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
 - 2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
 - 3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design".
 - 4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
 - 5. AISC's "Specification for Allowable Stress Design of Single-Angle Members".
 - 6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- F. Mockups: Build mockups of architecturally exposed structural steel to set quality standards for fabrication and installation.
 - 1. Coordinate finish painting requirements with Division 9 painting Sections.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from erosion and deterioration.
 - 1. Store fasteners in a protected place. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

1.7 COORDINATION

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

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 572/A 572M, Grade 50.

- B. Channels, Angles, M, S-Shapes: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M.
- D. Corrosion-Resisting Structural Steel: ASTM A 588/A 588M, Grade 50.
- E. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade [B] [C], structural tubing.
- F. Corrosion-Resisting Cold-Formed Hollow Structural Sections: ASTM A 847, structural tubing.
- G. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
 - 1. Weight Class: As noted on drawings.
 - 2. Finish: Black, except where indicated to be galvanized.
- H. Medium-Strength Steel Castings: ASTM A 27/A 27M, Grade 65-35, carbon steel.
- I. High-Strength Steel Castings: ASTM A 148/A 148M, Grade 80-50, carbon or alloy steel.
- J. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
 - 1. Finish: Plain.
 - 2. Direct-Tension Indicators: ASTM F 959, Type 325 compressible-washer type.
 - a. Finish: Plain.
- B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1, Type B.
- C. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 heavy hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436 hardened carbon steel.
 - 5. Finish: Plain.
- D. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable.
 - 1. Nuts: ASTM A 563 heavy hex carbon steel.
 - 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 3. Washers: ASTM F 436 hardened carbon steel.
 - 4. Finish: Plain.

- E. Threaded Rods: ASTM A 36/A 36M.
 - 1. Nuts: ASTM A 563 heavy hex carbon steel.
 - 2. Washers: ASTM A 36/A 36M carbon steel.
 - 3. Finish: Plain.
- F. Clevises Turnbuckles: ASTM A 108, Grade 1035, cold-finished carbon steel.
- G. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.
- H. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.

2.3 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.
- B. Galvanizing Repair Paint: ASTM A 780.

2.4 GROUT

- A. 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.
- B. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- C. 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.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
 - 1. Camber structural-steel members where indicated.
 - 2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
 - 3. Mark and match-mark materials for field assembly.
 - 4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. 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.

1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, seam marks, roller marks, rolled trade names, and roughness.
 2. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
- 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, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- E. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- F. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning."
- G. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.
- H. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.
- I. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk, cross-recessed head machine screws, uniformly spaced not more than 10 inches o.c., unless otherwise indicated.
- J. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded.
 3. Surfaces to be high-strength bolted with slip-critical connections.
 4. Surfaces to receive sprayed fire-resistive materials.
 5. 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 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 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/ A 123M.
 1. Fill vent holes and grind smooth after galvanizing.
 2. Galvanize lintels attached to structural-steel frame and located in exterior walls.

2.9 SOURCE QUALITY CONTROL

- A. Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 1. Liquid Penetrant Inspection: ASTM E 165.
 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 3. Ultrasonic Inspection: ASTM E 164.
 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1 for stud welding and as follows:
 1. Bend tests will be performed if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.
 2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place, unless otherwise indicated.
 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."
- 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. Maintain erection tolerances of structural steel and architecturally exposed structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1.
- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- I. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1 and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- 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--Allowable Stress Design and Plastic Design" 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. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
 - 4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
 - a. Grind butt welds flush.
 - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM 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, full penetration field welds will be tested according to AWS D1.1 and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1 for stud welding and as follows:
 - 1. Perform bend tests if visual inspections reveal either a less-than- continuous 360-degree flash or welding repairs to any shear connector.

2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. 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. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

END OF SECTION 05 12 00

SECTION 05 5000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel framing and supports for countertops.
 - 2. Steel framing and supports for mechanical and electrical equipment.
 - 3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 4. Slotted channel framing.
 - 5. Metal bollards.
 - 6. Loose bearing and leveling plates for applications where they are not specified in other Sections.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Loose steel lintels.
 - 2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
- C. Related Requirements:
 - 1. Section 04 2000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
 - 2. Section 04 4313.13 "Anchored Stone Masonry Veneer" for installing loose lintels, anchor bolts, and other items built into stone veneer.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Fasteners.
 - 2. Shop primers.
 - 3. Shrinkage-resisting grout.
 - 4. Slotted channel framing.
 - 5. Metal bollards.

- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:
 - 1. Steel framing and supports for countertops.
 - 2. Steel framing and supports for mechanical and electrical equipment.
 - 3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 4. Metal bollards.
 - 5. Loose steel lintels.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

- C. Research Reports: For post-installed anchors.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
1. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm).
 2. Material: Galvanized steel, ASTM A653/A653M, commercial steel, Type B, with G90 (Z275) coating; 0.064-inch (1.6-mm) nominal thickness.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ASTM F568M, Property Class 4.6); with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, (ASTM A563M, Class 10S3) heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593 (ASTM F738M); with hex nuts, ASTM F594 (ASTM F836M); and, where indicated, flat washers; Alloy Group 1 (A1).

- E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, **ASTM A563 (ASTM A563M)**; and, where indicated, flat washers.
 - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless steel bolts, **ASTM F593 (ASTM F738M)**, and nuts, **ASTM F594 (ASTM F836M)**.
- I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, **1-5/8 by 7/8 inches (41 by 22 mm)** by length indicated with anchor straps or studs not less than **3 inches (75 mm)** long at not more than **8 inches (200 mm)** o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

- A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- B. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- C. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- F. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

- G. Concrete: Comply with requirements in Section 03 3000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
 - 1. Fabricate units from slotted channel framing where indicated.
 - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with zinc-rich primer unless otherwise indicated.

2.7 METAL BOLLARDS

- A. Fabricate metal bollards from Schedule 40 steel pipe.
 - 1. Cap bollards with 1/4-inch- (6.4-mm-) thick, steel plate with domed top.
 - 2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
 - 3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.
- B. Fabricate sleeves for bollard anchorage from steel or stainless steel pipe or tubing with 1/4-inch- (6.4-mm-) thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches (200 mm) deep and 3/4 inch (19 mm) larger than OD of bollard.
- C. Prime steel bollards with zinc-rich primer.

2.8 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize bearing and leveling plates.
- C. Prime plates with zinc-rich primer.

2.9 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches (200 mm) unless otherwise indicated.
- C. Galvanize and prime loose steel lintels located in exterior walls.
- D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.10 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.11 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.12 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.
- C. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
 - 1. Shop prime with universal shop primer unless zinc-rich primer is indicated.
- D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
 - 1. Cast Aluminum: Heavy coat of bituminous paint.
 - 2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 INSTALLATION OF METAL BOLLARDS

- A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

- B. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately **1/8 inch (3 mm)** toward bollard.
- C. Anchor bollards in place with concrete footings. Center and align bollards in holes **3 inches (75 mm)** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
- D. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes **3 inches (75 mm)** above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.
- E. Fill bollards solidly with concrete, mounding top surface to shed water.

3.4 INSTALLATION OF BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 REPAIRS

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum **2.0-mil (0.05-mm)** dry film thickness.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 5000

SECTION 06 1000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Framing with dimension lumber.
 - 2. Framing with engineered wood products.
 - 3. Wood blocking and nailers.
 - 4. Wood furring and grounds.
 - 5. Plywood backing panels.
- B. Related Requirements:
 - 1. Section 06 1600 "Sheathing" for roof and wall sheathing.
 - 2. Section 31 3116 "Termite Control" for site application of borate treatment to wood framing.

1.3 DEFINITIONS

- A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) size or greater but less than 5 inches nominal (114 mm actual) size in least dimension.
- C. Exposed Framing: Framing not concealed by other construction.
- D. OSB: Oriented strand board.
- E. Timber: Lumber of 5 inches nominal (114 mm actual) size or greater in least dimension.
- F. Lumber grading agencies, and abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NLGA: National Lumber Grades Authority.
 - 3. SPIB: The Southern Pine Inspection Bureau.
 - 4. WCLIB: West Coast Lumber Inspection Bureau.
 - 5. WWPA: Western Wood Products Association.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
- B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates:
 - 1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
- B. Reports: For the following, from ICC-ES:
 - 1. Wood-preservative-treated wood.
 - 2. Engineered wood products.
 - 3. Power-driven fasteners.
 - 4. Post-installed anchors.
 - 5. Metal framing anchors.
 - 6. Sill sealer gasket/termite barrier.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.

2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
 4. Dress lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content of Lumber:
1. Dimension Lumber: 15 percent unless otherwise indicated.
- C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

2.2 PRESERVATIVE TREATMENT

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Do not use inorganic boron (SBX) for sill plates.
 2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
 3. After treatment, redry dimension lumber to 15 percent maximum moisture content.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or that does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
- D. Application: Treat items indicated on Drawings, and the following:
1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
 2. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.
 3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.

4. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 DIMENSION LUMBER FRAMING

- A. Non-Load-Bearing Interior Partitions by Grade: Construction or No. 2 grade.
 1. Application: All interior partitions.
 2. Species:
 - a. Southern pine or mixed southern pine; SPIB.
- B. Load-Bearing Partitions by Grade: No. 2 grade.
 1. Application: Exterior walls and interior load-bearing partitions.
 2. Species:
 - a. Southern pine or mixed southern pine; SPIB.
- C. Joists, Rafters, and Other Framing by Grade: No. 2 grade.
 1. Species:
 - a. Southern pine or mixed southern pine; SPIB.
- D. Exposed Framing: Hand-select material for uniformity of appearance and freedom from characteristics, on exposed surfaces and edges, that would impair finish appearance, including decay, honeycomb, knot-holes, shake, splits, torn grain, and wane.
 1. Species and Grade:
 - a. Southern pine; Select Structural grade; SPIB.

2.4 ENGINEERED WOOD PRODUCTS

- A. Source Limitations: Obtain each type of engineered wood product from single source from a single manufacturer.
- B. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D5456 and manufactured with an exterior-type adhesive complying with ASTM D2559.
 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. [Boise Cascade Company](#).
 - b. [Louisiana-Pacific Corporation](#).
 - c. [Weyerhaeuser Company](#).
 2. Extreme Fiber Stress in Bending, Edgewise: **2900 psi (20.0 MPa)** for **12-inch nominal- (286-mm actual-)** depth members.

3. Modulus of Elasticity, Edgewise: 1,800,000 psi (12 400 MPa).
4. Horizontal Shear: 225 psi (1.55 MPa).
5. Tension Parallel to Grain: 1500 psi (10.3 MPa).

C. Moisture Protection:

1. For western species (Douglas fir/hemlock), factory end and edge seal laminated veneer lumber with opaque moisture barrier.
2. For southern and eastern species (southern yellow pine, yellow poplar), factory seal laminated veneer lumber on face, edge, and ends.

D. Parallel-Strand Lumber: Structural composite lumber made from wood strand elements with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D5456 and manufactured with an exterior-type adhesive complying with ASTM D2559.

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. Cudahy Lumber Company.
 - b. Weyerhaeuser Company.
2. Extreme Fiber Stress in Bending, Edgewise: 2900 psi (20 MPa) for 12-inch nominal- (286-mm actual-) depth members.
3. Modulus of Elasticity, Edgewise: 2,200,000 psi (15 100 MPa).

2.5 MISCELLANEOUS LUMBER

- A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
1. Blocking.
 2. Nailers.
 3. Furring.
 4. Grounds.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of
1. Mixed southern pine or southern pine; SPIB.
- C. Concealed Boards: 15 percent maximum moisture content and the following species and grades:
1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

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

2.6 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, in thickness indicated or, if not indicated, not less than **3/4-inch (19-mm)** nominal thickness.

2.7 FASTENERS

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than **1-1/2 inches (38 mm)** into wood substrate.
 - 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329.
 - 2. For pressure-preservative-treated wood, use stainless steel fasteners.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC193 as appropriate for the substrate.

2.8 METAL FRAMING ANCHORS

- 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. [Phoenix Metal Products, Inc.](#)
 - 2. [Simpson Strong-Tie Co., Inc.](#)
 - 3. [Tamlyn.](#)
- B. Allowable design loads, as published by manufacturer, shall meet or exceed those of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.
- C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A653/A653M, **G60 (Z180)** coating designation.
 - 1. Use for interior locations unless otherwise indicated.

- D. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A653/A653M; structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
1. Use for wood-preserved-treated lumber, exterior locations, and where indicated.
- E. Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.
1. Thickness: 0.050 inch (1.3 mm).
- F. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
1. Strap Width: 1-1/2 inches (38 mm).
 2. Thickness: 0.050 inch (1.3 mm).
- G. Bridging: Rigid, V-section, nailless type, 0.050 inch (1.3 mm) thick, length to suit joist size and spacing.
- H. Post Bases: Adjustable-socket type for bolting in place with standoff plate to raise post 1 inch (25 mm) above base and with 2-inch- (50-mm-) minimum side cover, socket 0.062 inch (1.6 mm) thick, and standoff and adjustment plates 0.108 inch (2.8 mm) thick.
- I. Joist Ties: Flat straps, with holes for fasteners, for tying joists together over supports.
1. Width: 3/4 inch (19 mm).
 2. Thickness: 0.050 inch (1.3 mm).
 3. Length: As indicated.
- J. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-1/2 inches (38 mm) wide by 0.050 inch (1.3 mm) thick. Tie fastens to side of rafter or truss, face of top plates, and side of stud below.
- K. Floor-to-Floor Ties: Flat straps, with holes for fasteners, for tying upper floor wall studs to band joists and lower floor studs, 1-1/4 inches (32 mm) wide by 0.050 inch (1.3 mm) thick by 36 inches (914 mm) long.
- L. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.
1. Bolt Diameter: 5/8 inch (15.8 mm).
 2. Width: 2-1/2 inches (64 mm).
 3. Body Thickness: 0.108 inch (2.8 mm).
 4. Base Reinforcement Thickness: 0.108 inch (2.8 mm).
- M. Wall Bracing:
1. T-shaped bracing made for letting into studs in saw kerf, 1-1/8 inches (29 mm) wide by 9/16 inch (14 mm) deep by 0.034 inch (0.85 mm) thick with hemmed edges.

2. Angle bracing made for letting into studs in saw kerf, 15/16 by 15/16 by 0.040 inch (24 by 24 by 1 mm) thick with hemmed edges.

2.9 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets:
 1. Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to suit width of sill members indicated.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).
- C. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- C. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels.
- E. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- F. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.
- G. Do not splice structural members between supports unless otherwise indicated.
- H. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

- I. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than **96 inches (2438 mm)** o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than **96 inches (2438 mm)** o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and **2-inch nominal (38-mm actual)** thickness.
 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than **100 sq. ft. (9.3 sq. m)** and to solidly fill space below partitions.
 4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than **20 feet (6 m)** o.c.

- J. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

- K. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
 1. Use inorganic boron for items that are continuously protected from liquid water.
 2. Use copper naphthenate for items not continuously protected from liquid water.

- L. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

- M. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
 2. ICC-ES evaluation report for fastener.

- N. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

- O. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
 1. Comply with approved fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
 2. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.
 3. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILERS

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than **1-1/2 inches (38 mm)** wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 INSTALLATION OF WOOD FURRING

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install **1-by-3-inch nominal- (19-by-63-mm actual-)** size furring vertically at **24 inches (610 mm)** o.c.

3.4 INSTALLATION OF WALL AND PARTITION FRAMING

- A. General: Provide single bottom plate and double top plates using members of **2-inch nominal (38-mm actual)** thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions and for load-bearing partitions where framing members bearing on partition are located directly over studs. Fasten plates to supporting construction unless otherwise indicated.
 - 1. For exterior walls, provide **2-by-4-inch nominal- (38-by-89-mm actual-)** size wood studs spaced **16 inches (406 mm)** o.c. unless otherwise indicated.
 - 2. For interior partitions and walls, provide **2-by-4-inch nominal- (38-by-89-mm actual-)** size wood studs spaced **16 inches (406 mm)** o.c. unless otherwise indicated.
 - 3. Provide continuous horizontal blocking at midheight of partitions more than **96 inches (2438 mm)** high, using members of **2-inch nominal (38-mm actual)** thickness and of same width as wall or partitions.
- B. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.
- C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.
 - 1. For non-load-bearing partitions, provide double-jamb studs and headers not less than **4-inch nominal (89-mm actual)** depth for openings **48 inches (1200 mm)** and less in width, **6-inch nominal (140-mm actual)** depth for openings **48 to 72 inches (1200 to 1800 mm)** in width, **8-inch nominal (184-mm actual)** depth for openings **72 to 120 inches (1800 to 3000 mm)** in width, and not less than **10-inch nominal (235-mm actual)** depth for openings **10 to 12 feet (3 to 3.6 m)** in width.

2. For load-bearing walls, provide double-jamb studs for openings **60 inches (1500 mm)** and less in width, and triple-jamb studs for wider openings. Provide headers of depth indicated.
- D. Provide diagonal bracing in exterior walls, at both walls of each external corner, at 45-degree angle, full-story height unless otherwise indicated. Use **1-by-4-inch nominal- (19-by-89-mm actual-)** size boards, let-in flush with faces of studs.

3.5 INSTALLATION OF RAFTER FRAMING

- A. Rafters: Notch to fit exterior wall plates and use metal framing anchors. Double rafters to form headers and trimmers at openings in roof framing, if any, and support with metal hangers. Where rafters abut at ridge, place directly opposite each other and nail to ridge member or use metal ridge hangers.
1. At valleys, provide double-valley rafters of size indicated or, if not indicated, of same thickness as regular rafters and **2 inches (50 mm)** deeper. Bevel ends of jack rafters for full bearing against valley rafters.
 2. At hips, provide hip rafter of size indicated or, if not indicated, of same thickness as regular rafters and **2 inches (50 mm)** deeper. Bevel ends of jack rafters for full bearing against hip rafter.
- B. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions if any.

3.6 PROTECTION

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

END OF SECTION 06 1000

SECTION 06 1516 - WOOD ROOF DECKING

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 solid-sawn wood roof decking

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For glued-laminated wood roof decking, include installation instructions and data on lumber, adhesives, and fabrication.
 - 2. For preservative-treated wood products, include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.
 - 3. Product Data for Credit IEQ 4.4: For laminating adhesive used for glued-laminated roof decking, documentation indicating that product contains no urea formaldehyde.
- B. Samples: 24 inches (600 mm) long, showing the range of variation to be expected in appearance of wood roof decking.

1.4 INFORMATIONAL SUBMITTALS

- A. Research/Evaluation Reports: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Schedule delivery of wood roof decking to avoid extended on-site storage and to avoid delaying the Work.
- B. Store materials under cover and protected from weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings. Stack wood roof decking with surfaces that are to be exposed in the final Work protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 WOOD ROOF DECKING, GENERAL

- A. General: Comply with DOC PS 20 and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
- B. Regional Materials: Wood roof decking shall be manufactured within 500 miles (800 km) of Project site from wood that has been harvested and milled within 500 miles (800 km) of Project site.
- C. Regional Materials: Wood roof decking shall be manufactured within 500 miles (800 km) of Project site.
- D. Certified Wood: Wood roof decking shall be certified as "FSC Pure"[or "FSC Mixed Credit"] according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

2.2 SOLID-SAWN WOOD ROOF DECKING

- A. Standard for Solid-Sawn Wood Roof Decking: Comply with AITC 112.
- B. Roof Decking Species: Balsam fir, Douglas fir-larch, Douglas fir-larch (North), hem-fir, hem-fir (North), southern pine, spruce pine-fir (North), western hemlock, or western hemlock (North).
- C. Roof Decking Species: Douglas fir-larch or Southern pine
- D. Roof Decking Nominal Size: 2 by 6
- E. Roof Decking Grade: Select Decking.
- F. Grade Stamps: Factory mark each item with grade stamp of grading agency. Apply grade stamp to surfaces that are not exposed to view.
- G. Moisture Content: Provide wood roof decking with 15 percent maximum moisture content at time of dressing.
- H. Face Surface: Smooth.

- I. Edge Pattern: Vee grooved.

2.3 PRESERVATIVE TREATMENT

- A. Pressure treat wood roof decking according to AWPA U1; Use Category UC2.
 1. For laminated roof decking, treat lumber before gluing.
- B. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
 1. For exposed items indicated to receive a stained or natural finish, use products that do not contain colorants, bleed through, or otherwise adversely affect finishes.
- C. Use process that includes water-repellent treatment.
- D. Use process that does not include water repellents or other substances that might interfere with application of indicated finishes.
- E. After treatment, redry materials to 19 percent maximum moisture content.
- F. After dressing and fabricating roof decking, apply inorganic boron or copper naphthenate according to AWPA M4 to surfaces cut to a depth of more than 1/16 inch (1.5 mm).

2.4 ACCESSORY MATERIALS

- A. Fasteners for Solid-Sawn Roof Decking: Provide fastener size and type complying with AITC 112 for thickness of deck used.
- B. Fasteners for Glued-Laminated Roof Decking: Provide fastener size and type complying with requirements in "Installation" Article for installing laminated roof decking.
- C. Nails: Common; complying with ASTM F 1667, Type I, Style 10.
- D. Spikes: Round; complying with ASTM F 1667, Type III, Style 3.
- E. Fastener Material: Hot-dip galvanized steel.
- F. Bolts for Anchoring Roof Decking to Walls: Carbon steel; complying with ASTM A 307 (ASTM F 568M) with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers, all hot-dip zinc coated.
- G. Installation Adhesive: For glued-laminated wood roof decking indicated to be of diaphragm design and construction, provide adhesive that complies with research/evaluation report.
 1. Adhesives shall have a VOC content of 70g/L or less.
 2. Adhesives shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services')

"Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

- H. Sealants: Latex, complying with ASTM C 834 Type OP, Grade NF with applicable requirements in Section 079200 "Joint Sealants," recommended by sealant manufacturer and manufacturer of substrates for intended application.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BASF Building Systems; Sonolac.
 - b. Bostik, Inc; Chem-Calk 600.
 - c. May National Associates, Inc; Bondaflex 600, Bondaflex Sil-A 700.
 - d. Pecora Corporation; AC-20+.
 - e. Schnee-Morehead, Inc., an ITW company; SM 8200.
 - f. Tremco Incorporated; Tremflex 834.
 2. Sealants shall have a VOC content of 250g/L or less.
 3. Sealants shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- I. Penetrating Sealer: Clear sanding sealer complying with Section 099300 "Staining and Transparent Finishing" and compatible with topcoats specified for use over it.
1. Sealers shall have a VOC content of 350g/L or less.
 2. Sealers shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 FABRICATION

- A. Shop Fabrication: Where preservative-treated roof decking is indicated, complete cutting, trimming, surfacing, and sanding before treating.
- B. Predrill roof decking for lateral spiking to adjacent units to comply with AITC 112.
- C. Seal Coat: After fabricating and surfacing roof decking, apply a saturation coat of penetrating sealer.
- D. Apply indicated finish materials to comply with Section 099300 "Staining and Transparent Finishing" in fabrication shop.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and support framing in areas to receive wood roof decking for compliance with installation tolerances and other conditions affecting performance of wood roof decking.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install solid-sawn wood roof decking to comply with AITC 112.
 - 1. Locate end joints for controlled random lay-up.
- B. Install laminated wood roof decking to comply with manufacturer's written instructions.
 - 1. Locate end joints for controlled random lay-up.
 - 2. Nail each course of glued-laminated wood roof decking at each support with one nail slant nailed above the tongue and one nail straight nailed through the face.
 - a. Use 12d nails for 2-by-6 and 2-by-8 roof decking.
 - b. Use 30d nails for 3-by-6 and 3-by-8 roof decking.
 - c. Use 60d nails for 4-by-6 and 4-by-8 roof decking. Predrill roof decking to prevent splitting.
 - d. Use 30d tongue nails in bottom tongue and 3/8-inch (10-mm) face spikes for 5-by-6 and 5-by-8 roof decking. Predrill roof decking at spikes to prevent splitting.
 - 3. Slant nail each course of glued-laminated wood roof decking to the tongue of the adjacent course at 30 inches (750 mm) o.c. and within 12 inches (300 mm) of the end of each unit. Stagger nailing 15 inches (380 mm) in adjacent courses.
 - a. Use 6d nails for 2-by-6 and 2-by-8 roof decking.
 - b. Use 8d nails for 3-by-6 and 3-by-8 roof decking.
 - c. Use 10d nails for 4-by-6 and 4-by-8 roof decking.
 - d. Use 16d nails for 5-by-6 and 5-by-8 roof decking.
 - 4. Glue adjoining roof decking courses together by applying a 3/8-inch (10-mm) bead of adhesive to the top of tongues, according to research/evaluation report.
- C. Anchor wood roof decking, where supported on walls, with bolts as indicated.
- D. Where preservative-treated roof decking must be cut during erection, apply a field-treatment preservative to comply with AWPA M4.
 - 1. For solid-sawn roof decking, use inorganic boron (SBX).
 - 2. For laminated roof decking, use copper naphthenate.
- E. Apply joint sealant to seal roof decking at exterior walls at the following locations:

1. Between roof decking and supports located at exterior walls.
2. Between roof decking and exterior walls that butt against underside of roof decking.
3. Between tongues and grooves of roof decking over exterior walls and supports at exterior walls.

3.3 ADJUSTING

- A. Repair damaged surfaces and finishes after completing erection. Replace damaged roof decking if repairs are not approved by Architect.

3.4 PROTECTION

- A. Provide water-resistive barrier over roof decking as the Work progresses to protect roof decking until roofing is applied.
- B. If, despite protection, roof decking becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061516

SECTION 06 1600 - SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Wall sheathing.
 - 2. Roof substrate.
 - 3. Roof sheathing.
 - 4. Composite nail base insulated roof sheathing.
- B. Related Requirements:
 - 1. Section 06 1000 "Rough Carpentry" for plywood backing panels.
 - 2. Section 07 2500 "Weather Barriers" for weather barrier applied over wall sheathing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
 - 2. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preservative-treated plywood.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PANEL PRODUCTS

- A. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- B. Factory mark panels to indicate compliance with applicable standard.

2.2 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
 - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat all plywood unless otherwise indicated.

2.3 WALL SHEATHING

- A. Plywood Sheathing: Exterior, Structural I sheathing.
 - 1. Span Rating: Not less than 24/0.
 - 2. Nominal Thickness: Not less than 1/2 inch (13 mm).

2.4 ROOF SUBSTRATE

- A. Plywood Sheathing: Exterior, Structural I sheathing.
 - 1. Span Rating: Not less than 24/0.
 - 2. Nominal Thickness: Not less than 1/2 inch (13 mm).

2.5 ROOF SHEATHING

- A. Plywood Sheathing: Exterior, Structural I sheathing.
 - 1. Span Rating: Not less than 24/0.
 - 2. Nominal Thickness: Not less than 1/2 inch (13 mm).

2.6 COMPOSITE NAIL BASE INSULATED ROOF SHEATHING

- A. Oriented-Strand-Board-Surfaced, Polyisocyanurate-Foam Sheathing: ASTM C1289, Type V with DOC PS 2, Exposure 1 oriented strand board on one face.
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. Hunter Panels.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Rmax, Inc.
 2. Polyisocyanurate-Foam Thickness: **1-1/2 inches (38 mm)**.
 3. Oriented-Strand-Board Nominal Thickness: **5/8 inch (15.9 mm)**.

2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with ASTM D3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

- C. Securely attach to substrate by fastening as indicated, complying with the following:
 - 1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
 - 2. ICC-ES evaluation report for fastener.
- D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate wall 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.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.
- B. Fastening Methods: Fasten panels as indicated below:
 - 1. Wall and Roof Sheathing:
 - a. Nail to wood framing. Apply a continuous bead of glue to framing members at edges of wall sheathing panels.
 - b. Space panels **1/8 inch (3 mm)** apart at edges and ends.

END OF SECTION 06 1600

SECTION 06 2013 - EXTERIOR FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior wood trim.
- B. Related Requirements:
 - 1. Section 06 1000 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view and for framing exposed to view.
 - 2. Section 07 4646 "Fiber-Cement Siding" for siding panels and fascia.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.
 - 1. Include data for wood-preservative treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained. Include chemical-treatment manufacturer's written instructions for finishing treated material.
 - 2. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.
- B. Samples: For each species and cut of lumber and panel products, with half of exposed surface finished.

1.4 INFORMATIONAL SUBMITTALS

- A. Compliance Certificates:
 - 1. For lumber that is not marked with grade stamp.
 - 2. For preservative-treated wood that is not marked with treatment-quality mark.
- B. Evaluation Reports: For the following, from ICC-ES:
 - 1. Wood-preservative-treated wood.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation.
 - 1. Protect materials from weather by covering with waterproof sheeting, securely anchored.
 - 2. Provide for air circulation around stacks and under coverings.

1.6 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecast weather conditions permit work to be performed and at least one coat of specified finish can be applied without exposure to rain, snow, or dampness.
- B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with applicable rules of any rules-writing agency certified by the American Lumber Standard Committee's (ALSC) Board of Review. Grade lumber by an agency certified by the ALSC's Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of inspection agency, indicating grade, species, moisture content at time of surfacing, and mill.
 - 2. For exposed lumber, mark grade stamp on end or back of each piece, or omit grade stamp and provide certificates of grade compliance issued by inspection agency.
- B. Softwood Plywood: DOC PS 1.
- C. Hardboard: ANSI A135.4.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC3a.
 - 1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 18 percent, respectively.
 - 2. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

3. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
4. Do not use material that is warped or does not comply with requirements for untreated material.
5. Mark lumber with treatment-quality mark of an inspection agency approved by the ALSC's Board of Review.
 - a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.
6. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
 - a. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.
7. Application: All exterior lumber and plywood.

2.3 EXTERIOR TRIM

A. Lumber Trim for Painted Finish:

1. Species and Grade: Eastern white pine, eastern hemlock-balsam fir-tamarack, eastern spruce, or white woods; NeLMA, NLGA, WCLIB, or WWPA Finish or 1 Common (Colonial).
2. Maximum Moisture Content: 19 percent.
3. Finger Jointing: Allowed if made with wet-use adhesive complying with ASTM D5572.
4. Face Surface: Surfaced (smooth).
5. Factory Priming: Factory coated on both faces and all edges, with exterior primer compatible with topcoats specified.

B. Primed Hardboard Trim: ANSI A135.6, primed with manufacturer's standard exterior primer. Recommended by manufacturer for exterior use.

2.4 MISCELLANEOUS MATERIALS

A. Fasteners for Exterior Finish Carpentry: Provide nails or screws, in sufficient length to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.

1. For prefinished items, provide matching prefinished aluminum fasteners where face fastening is required.
2. For pressure-preservative-treated wood, provide hot-dip galvanized-steel fasteners.
3. For applications not otherwise indicated, provide hot-dip galvanized-steel fasteners.

B. Wood Glue: Waterproof resorcinol glue recommended by manufacturer for exterior carpentry use.

C. Flashing: Comply with requirements in Section 07 6200 "Sheet Metal Flashing and Trim" for flashing materials installed in exterior finish carpentry.

2.5 FABRICATION

- A. Back out or kerf backs of standing and running trim wider than **5 inches (125 mm)**, except members with ends exposed in finished work.
- B. Ease edges of lumber less than **1 inch (25 mm)** in nominal thickness to **1/16-inch (1.5-mm)** radius and edges of lumber **1 inch (25 mm)** or more in nominal thickness to **1/8-inch (3-mm)** radius.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.
- B. Prime lumber and moldings to be painted, including both faces and edges, unless factory primed.
 - 1. Cut to required lengths and prime ends.
 - 2. Comply with requirements in Section 09 9113 "Exterior Painting."

3.3 INSTALLATION, GENERAL

- A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
- B. Install exterior finish carpentry level, plumb, true, and aligned with adjacent materials.
 - 1. Use concealed shims where necessary for alignment.
 - 2. Scribe and cut exterior finish carpentry to fit adjoining work.
 - 3. Refinish and seal cuts as recommended by manufacturer.
 - 4. Install to tolerance of **1/8 inch in 96 inches (3 mm in 2438 mm)** for level and plumb. Install adjoining exterior finish carpentry with **1/32-inch (0.8-mm)** maximum offset for flush installation and **1/16-inch (1.5-mm)** maximum offset for reveal installation.
 - 5. Coordinate exterior finish carpentry with materials and systems in or adjacent to it.
 - 6. Provide cutouts for mechanical and electrical items that penetrate exterior finish carpentry.

3.4 INSTALLATION OF STANDING AND RUNNING TRIM

- A. Install flat-grain lumber with bark side exposed to weather.
- B. Install trim with minimum number of joints as is practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than **24 inches (610 mm)** long, except where necessary.
 - 1. Use scarf joints for end-to-end joints.
 - 2. Stagger end joints in adjacent and related members.
- C. Fit exterior joints to exclude water.
 - 1. Cope at returns and miter at corners to produce tight-fitting joints, with full-surface contact throughout length of joint.
 - 2. Plane backs of casings to provide uniform thickness across joints, where necessary for alignment.
- D. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.

3.5 ADJUSTING

- A. Replace exterior finish carpentry that is damaged or does not comply with requirements.
 - 1. Exterior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.
- B. Adjust joinery for uniform appearance.

3.6 CLEANING

- A. Clean exterior finish carpentry on exposed and semiexposed surfaces.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.

3.7 PROTECTION

- A. Protect installed products from damage from weather and other causes during construction.
- B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.
 - 1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

Lake Tawakoni Tournament Facility - Restroom,
Hardscape, and Landscape
VAN ZANDT COUNTY, TEXAS
SRA PROJECT NO. 2002

ISSUE FOR BID
September 8, 2022

END OF SECTION 06 2013

SECTION 07 2500 - WEATHER BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wrap.
 - 2. Flexible flashing.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For building wrap, include data on air and water-vapor permeance based on testing according to referenced standards.
- B. Shop Drawings: Show details of building wrap at terminations, openings, and penetrations. Show details of flexible flashing applications.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For water-resistive barrier and flexible flashing, from ICC-ES.

PART 2 - PRODUCTS

2.1 WATER-RESISTIVE BARRIER

- A. Building Wrap: ASTM E1677, Type I air barrier; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E84; UV stabilized; and acceptable to authorities having jurisdiction.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. DuPont de Nemours, Inc.; Tyvek CommercialWrap.
 - b. Kingspan Insulation Limited; GreenGuard MAX Building Wrap.
 - c. TYPAR; TYPAR® Commercial Grade MetroWrap.

2. Water-Vapor Permeance: Not less than **20 perms** (1150 ng/Pa x s x sq. m) per ASTM E96/E96M, Desiccant Method (Procedure A).
 3. Air Permeance: Not more than **0.004 cfm/sq. ft. at 0.3-inch wg** (0.02 L/s x sq. m at 75 Pa) when tested according to ASTM E2178.
 4. Allowable UV Exposure Time: Not less than three months.
 5. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.
- B. Building-Wrap Tape: Pressure-sensitive plastic tape recommended by building-wrap manufacturer for sealing joints and penetrations in building wrap.

2.2 FLEXIBLE FLASHING

- A. Butyl Rubber Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than **0.025 inch (0.6 mm)**.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. **DuPont de Nemours, Inc.;** DuPont Flashing Tape.
 - b. **Protecto Wrap Company;** BT-25 XL.
 - c. **TYPAR;** TYPAR® All-Temperature Flashing.
 2. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.
- B. Primer for Flexible Flashing: Product recommended in writing by flexible flashing manufacturer for substrate.
- C. Nails and Staples: Product recommended in writing by flexible flashing manufacturer and complying with ASTM F1667.

PART 3 - EXECUTION

3.1 WATER-RESISTIVE BARRIER INSTALLATION

- A. Cover exposed exterior surface of sheathing with water-resistive barrier securely fastened to framing immediately after sheathing is installed.
- B. Cover sheathing with water-resistive barrier as follows:
1. Cut back barrier **1/2 inch (13 mm)** on each side of the break in supporting members at expansion- or control-joint locations.
 2. Apply barrier to cover vertical flashing with a minimum **4-inch (100-mm)** overlap unless otherwise indicated.
- C. Building Wrap: Comply with manufacturer's written instructions and warranty requirements.

1. Seal seams, edges, fasteners, and penetrations with tape.
2. Extend into jambs of openings and seal corners with tape.

3.2 FLEXIBLE FLASHING INSTALLATION

A. Apply flexible flashing where indicated to comply with manufacturer's written instructions.

1. Prime substrates as recommended by flashing manufacturer.
2. Lap seams and junctures with other materials at least **4 inches (100 mm)** except that at flashing flanges of other construction, laps need not exceed flange width.
3. Lap flashing over water-resistive barrier at bottom and sides of openings.
4. Lap water-resistive barrier over flashing at heads of openings.
5. After flashing has been applied, roll surfaces with a hard rubber or metal roller to ensure that flashing is completely adhered to substrates.

END OF SECTION 07 2500

SECTION 07 4113.16 - STANDING-SEAM METAL ROOF PANELS

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. Standing-seam metal roof panels.

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 each type of panel and accessory.
- B. Shop Drawings:
 - 1. Include 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.
 - 2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than **1-1/2 inches per 12 inches (1:10)**.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Metal Panels: **12 inches (305 mm)** long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For special warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For metal panels to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal 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. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Retain strippable protective covering on metal panels during installation.
- E. Copper Panels: Wear gloves when handling to prevent fingerprints and soiling of surface.

1.8 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.9 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems 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 and other materials beyond normal weathering.
 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:
1. Wind Loads: As indicated on Drawings.
 2. Other Design Loads: As indicated on Drawings.
 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:
1. Test-Pressure Difference: 6.24 lbf/sq. ft. (300 Pa).
- C. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
1. Uplift Rating: UL 90.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

- A. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
 2. Aluminum Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1637.
- B. Vertical-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.
1. Basis-of-Design Product: Subject to compliance with requirements, provide PAC-CLAD; Petersen Aluminum Corporation; a Carlisle company; Snap-Clad or a comparable product by one of the following:
 - a. CENTRIA.
 - b. MBCI.
 - c. Morin - A Kingspan Group Company.
 2. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, **G90 (Z275)** coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, **Class AZ50 (Class AZM150)** coating designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A755/A755M.
 - a. Nominal Thickness: **0.028 inch (0.71 mm)**.
 - b. Exterior Finish: Two-coat fluoropolymer.
 - c. Color: Dark Bronze.
 3. Clips: One-piece fixed to accommodate thermal movement.
 - a. Material: **0.028-inch- (0.71-mm-)** nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.
 4. Panel Coverage: **18 inches (457 mm)**.
 5. Panel Height: **1.75 inches (44 mm)**.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of **30 mils (0.76 mm)** thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F (116 deg C); ASTM D1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F (29 deg C); ASTM D1970.
 3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Carlisle WIP Products; a brand of Carlisle Construction Materials; WIP 300HT.
 - b. Henry Company; Blueskin PE200 HT.
 - c. Owens Corning; WeatherLock Metal High-Temperature Underlayment.
- B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.4 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Subframing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A792/A792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
 2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
 3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, valleys, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch- (2400-mm-) long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (914 mm) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match roof fascia and rake trim.
- E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot- (3-m-) long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

- F. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
 - 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape **1/2 inch (13 mm)** wide and **1/8 inch (3 mm)** thick.
 - 2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.5 FABRICATION

- A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- D. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to 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. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 4. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
 - 5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
 - 6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.
 - a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

- A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Steel Panels and Accessories:
 - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 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 the Work.
 - 1. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
- B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF UNDERLAYMENT

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply over the entire roof surface, wrinkle free, in shingle fashion to shed water, and with end laps of not less than **6 inches (152 mm)** staggered **24 inches (610 mm)** between courses. Overlap side edges not less than **3-1/2 inches (90 mm)**. Extend underlayment into gutter trough. Roll laps with roller. Cover underlayment within 14 days.
- B. Slip Sheet: Apply slip sheet over underlayment before installing metal roof panels.
- C. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 07 6200 "Sheet Metal Flashing and Trim."

3.4 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

- A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
 - 1. Shim or otherwise plumb substrates receiving metal panels.
 - 2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
 - 3. Install screw fasteners in predrilled holes.
 - 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 5. Install flashing and trim as metal panel work proceeds.
 - 6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
 - 7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
 - 8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.
- B. Fasteners:
 - 1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.
 - 2. Aluminum Panels: Use aluminum or stainless steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.
 - 3. Copper Panels: Use copper, stainless steel, or hardware-bronze fasteners.
 - 4. Stainless Steel Panels: Use stainless steel fasteners.
- C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

- E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.
1. Install clips to supports with self-tapping fasteners.
 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
 4. Watertight Installation:
 - a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
 - b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
 - c. At panel splices, nest panels with minimum 6-inch (152-mm) end lap, sealed with sealant and fastened together by interlocking clamping plates.
- F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.
1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.
- G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).
- H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches (914 mm) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.
- I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1524 mm) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building where connection to underground drainage system is not indicated.
 2. Connect downspouts to underground drainage system where indicated.
- J. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal panel units within installed tolerance of **1/4 inch in 20 feet (6 mm in 6 m)** on slope and location lines as indicated and within **1/8-inch (3-mm)** offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.
- C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.
- D. Prepare test and inspection reports.

3.7 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 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 07 4113.16

SECTION 07 4646 - FIBER-CEMENT SIDING

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 fiber-cement board.
- B. Related Requirements:
 - 1. Section 06 1000 "Rough Carpentry" for wood furring, grounds, nailers, and blocking.
 - 2. Section 06 2013 "Exterior Finish Carpentry" for exterior trim.
 - 3. Section 07 2500 "Weather Barriers" for water resistive barriers.

1.3 COORDINATION

- A. Coordinate siding installation with flashings and other adjoining construction to ensure proper sequencing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples for Verification: For each type, color, texture, and pattern required.
 - 1. 12-inch- (300-mm-) long-by-actual-width Sample of fiber cement board.
 - 2. 12-inch- (300-mm-) long-by-actual-width Samples of trim and accessories.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of fiber-cement.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for fiber-cement siding.
- C. Research/Evaluation Reports: For each type of fiber-cement siding required, from ICC-ES.
- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of product, including related accessories, to include in maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with labels intact until time of use.
- B. Store materials on elevated platforms, under cover, and in a dry location.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace products that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including cracking and deforming.
 - b. Deterioration of materials beyond normal weathering.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.

2.2 FIBER-CEMENT BOARD

- A. General: ASTM C1186, Type A, Grade II, fiber-cement board, noncombustible when tested according to ASTM E136; with a flame-spread index of 25 or less when tested according to ASTM E84.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Certainteed; SAINT-GOBAIN.
 - b. James Hardie Building Products, Inc.
 - c. Nichiha Architectural Panels.
- B. Nominal Thickness: Not less than **5/16 inch (8 mm)**.

- C. Pattern: 24-inch- (600-mm-) wide sheets with smooth texture.
- D. Factory Priming: Manufacturer's standard acrylic primer.

2.3 ACCESSORIES

- A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.
 - 1. Provide accessories matching color and texture of adjacent siding unless otherwise indicated.
- B. Decorative Accessories: Provide the following fiber-cement decorative accessories as indicated:
 - 1. Fasciae.
 - 2. Moldings and trim.
- C. Flashing: Provide aluminum flashing complying with Section 07 6200 "Sheet Metal Flashing and Trim" at window and door heads and where indicated.
 - 1. Finish for Aluminum Flashing: Factory-prime coating.
- D. Fasteners:
 - 1. For fastening to wood, use siding nails of sufficient length to penetrate a minimum of 1 inch (25 mm) into substrate.
 - 2. For fastening to metal, use ribbed bugle-head screws of sufficient length to penetrate a minimum of 1/4 inch (6 mm), or three screw-threads, into substrate.
 - 3. For fastening fiber cement, use hot-dip galvanized fasteners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of fiber-cement board and related accessories.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of projections and substances detrimental to application.

3.3 INSTALLATION

- A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

1. Do not install damaged components.
 2. Install fasteners no more than **24 inches (600 mm)** o.c.
- B. Install joint sealants as specified in Section 07 9200 "Joint Sealants" and to produce a weathertight installation.

3.4 ADJUSTING AND CLEANING

- A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.
- B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 07 4646

SECTION 07 9200 - JOINT SEALANTS

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. Silicone joint sealants.
 - 2. Urethane joint sealants.
 - 3. Immersible joint sealants.
 - 4. Mildew-resistant joint sealants.
 - 5. Butyl joint sealants.
 - 6. Latex joint sealants.
- B. Related Requirements:
 - 1. Section 07 9219 "Acoustical Joint Sealants" for sealing joints in sound-rated construction.
 - 2. Section 32 1373 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Joint-sealants.
 - 2. Joint sealant backing materials.
- B. Samples for Initial Selection: Manufacturer's standard color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in **1/2-inch- (13-mm-)** wide joints formed between two **6-inch- (150-mm-)** long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Submittals:
 - 1. Field-Adhesion-Test Reports: For each sealant application tested.
- B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty Documentation:
 - 1. Manufacturers' special warranties.
 - 2. Installer's special warranties.

1.6 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installers: Authorized representative who is trained and approved by manufacturer.
 - 2. Testing Agency: Qualified in accordance with ASTM C1021 to conduct the testing indicated.

1.7 MOCKUPS

- A. Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

1.8 FIELD CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C).
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.9 WARRANTY

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
 1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
 2. Disintegration of joint substrates from causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

- A. Obtain joint sealants from single manufacturer for each sealant type.

2.2 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. VOC Content: Verify sealants and sealant primers comply with the following:
 1. Architectural sealants have a VOC content of 250 g/L or less.
 2. Sealants and sealant primers for nonporous substrates have a VOC content of 250 g/L or less.
 3. Sealants and sealant primers for porous substrates have a VOC content of 775 g/L or less.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

- a. [GE Construction Sealants; Momentive Performance Materials Inc.](#); SCS2700 SilPruf LM.
 - b. [Sika Corporation; Joint Sealants](#); SikaSil-C990.
- B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. [GE Construction Sealants; Momentive Performance Materials Inc.](#); SCS2000 SilPruf.
 - b. [Pecora Corporation](#); PCS.
 - c. [Sika Corporation; Joint Sealants](#); Sikasil WS-295 FPS.
 - d. [The Dow Chemical Company](#); Dow Corning® 791 Silicone Weatherproofing Sealant.
- C. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Pecora Corporation](#); 896FC.
 - b. [Sherwin-Williams Company \(The\)](#); White Lightning Silicone Ultra All Purpose Sealant.
 - c. [The Dow Chemical Company](#); DOW CORNING® 758 SILICONE WEATHER BARRIER SEALANT.

2.4 URETHANE JOINT SEALANTS

- A. Urethane, M, NS, 50, T, NT: Multicomponent, nonsag, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade NS, Class 50, Uses T and NT.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Tremco Incorporated](#); Dymeric 240.

2.5 IMMERSIBLE JOINT SEALANTS

- A. Urethane, Immersible, M, P, 25, T, NT, I: Immersible, multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 25, Uses T, NT, and I.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

- a. [LymTal International Inc](#); Iso-Flex 880 GB.
- b. [Master Builders Solutions](#); MasterSeal SL 2 (Pre-2014: Sonolastic SL2).
- c. [Sika Corporation; Joint Sealants](#); Sikaflex 2c SL.

2.6 MILDEW-RESISTANT JOINT SEALANTS

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.
 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. [GE Construction Sealants; Momentive Performance Materials Inc.](#); SCS1700 Sanitary.
 - b. [Pecora Corporation](#); Pecora 860.
 - c. [The Dow Chemical Company](#); DOW CORNING® 786 SILICONE SEALANT -.
 - d. [Tremco Incorporated](#); Tremsil 200.

2.7 BUTYL JOINT SEALANTS

- A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.
 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Bostik, Inc](#); Chem-Calk 300.
 - b. [Pecora Corporation](#); BC-158.

2.8 LATEX JOINT SEALANTS

2.9 LATEX JOINT SEALANTS

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.
 1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. [Pecora Corporation](#); AC-20.
 - b. [Sherwin-Williams Company \(The\)](#); 850A Siliconized Acrylic Latex Caulk.
 - c. [Tremco Incorporated](#); Tremflex 834.

2.10 JOINT-SEALANT BACKING

- A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. **Adfast;** Adseal BR 2600.
 - b. **Alcot Plastics Ltd.;** ALCOT Standard Backer Rod.
 - c. **Master Builders Solutions;** MasterSeal 920 & 921(Pre-2014: Sonolastic Backer Rod).
- B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.11 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and

- approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, 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.
 1. Do not leave gaps between ends of sealant backings.
 2. Do not stretch, twist, puncture, or tear sealant backings.
 3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile in accordance with Figure 8A in ASTM C1193 unless otherwise indicated.
 - 4. Provide flush joint profile at locations indicated on Drawings in accordance with Figure 8B in ASTM C1193.
 - 5. Provide recessed joint configuration of recess depth and at locations indicated on Drawings in accordance with Figure 8C in ASTM C1193.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

- B. Tests and Inspections:
 - 1. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
 - a. Extent of Testing: Test completed and cured sealant joints as follows:
 - 1) Perform one test for each 1000 ft. (300 m) of joint length thereafter or one test per each floor per elevation.

 - b. Test Method: Test joint sealants in accordance with Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
 - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

 - c. Inspect tested joints and report on the following:
 - 1) Whether sealants filled joint cavities and are free of voids.
 - 2) Whether sealant dimensions and configurations comply with specified requirements.

- 3) Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
 - d. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 - e. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
2. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
- C. Prepare test and inspection reports.

3.5 CLEANING

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

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

- A. Exterior joints in horizontal traffic surfaces:
1. Joint Locations:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Tile control and expansion joints.
 - c. Joints between different materials listed above.
 - d. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, M, NS, 50, T, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

- B. Exterior joints in horizontal traffic surfaces subject to water immersion:
1. Joint Locations:
 - a. Joints in pedestrian plazas.
 - b. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, Immersible, M, P, 25, T, NT, I.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Exterior joints in vertical surfaces and horizontal nontraffic surfaces:
1. Joint Locations:
 - a. Construction joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints between metal panels.
 - d. Joints between different materials listed above.
 - e. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
 - f. Control and expansion joints in ceilings and other overhead surfaces.
 - g. Insert other joints.
 - h. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, S, NS, 100/50, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Interior joints in horizontal traffic surfaces:
1. Joint Locations:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Urethane, M, NS, 50, T, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Interior joints in vertical surfaces and horizontal nontraffic surfaces:
1. Joint Locations:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Tile control and expansion joints.
 - c. Vertical joints on exposed surfaces of partitions.
 - d. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, S, NS, 50, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement:

1. Joint Locations:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Acrylic latex.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- G. Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces:
1. Joint Locations:
 - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- H. Concealed mastics:
1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Butyl-rubber based.
 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

END OF SECTION 07 9200

SECTION 08 1113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Exterior standard steel doors and frames.
- B. Related Requirements:
 - 1. Section 08 7100 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

1.4 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, core descriptions, and finishes.
- B. Shop Drawings: Include the following:
 - 1. Elevations of each door type.
 - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.

6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
 7. Details of anchorages, joints, field splices, and connections.
 8. Details of accessories.
 9. Details of moldings, removable stops, and glazing.
- C. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum **4-inch- (102-mm-)** high wood blocking. Provide minimum **1/4-inch (6-mm)** space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Ceco Door; ASSA ABLOY.
 2. Security Metal Products; a brand of ASSA ABLOY.
 3. Steelcraft; an Allegion brand.
 4. Titan Metal Products.

2.2 PERFORMANCE REQUIREMENTS

- A. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than **0.50 deg Btu/F x h x sq. ft. (2.84 W/K x sq. m)** when tested in accordance with ASTM C518.

2.3 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B..
1. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: **1-3/4 inches (44.5 mm)**.
 - c. Face: Metallic-coated steel sheet, minimum thickness of **0.042 inch (1.0 mm)**, with minimum **A60 (ZF180)** coating.
 - d. Edge Construction: Model 2, Seamless.
 - e. Edge Bevel: Bevel lock and hinge edges **1/8 inch in 2 inches (3.2 mm in 51 mm)**.
 - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
 - g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
 - h. Core: Polyisocyanurate.
 2. Frames:
 - a. Materials: Metallic-coated steel sheet, minimum thickness of **0.053 inch (1.3 mm)**, with minimum **A60 (ZF180)** coating.
 - b. Construction: Full profile welded.
 3. Exposed Finish: Prime.

2.4 FRAME ANCHORS

- A. Jamb Anchors:
1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
 2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each **24 inches (610 mm)** of frame height above **7 feet (2.1 m)**.
 3. Postinstalled Expansion Anchor: Minimum **3/8-inch- (9.5-mm-)** diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.

- C. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

2.5 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.
- F. Mineral-Fiber Insulation: ASTM C665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E136 for combustion characteristics.
- G. Glazing: Comply with requirements in Section 08 8000 "Glazing."

2.6 FABRICATION

- A. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.
 - 1. Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
- B. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.

2.7 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

2.8 LOUVERS

- A. Provide louvers for doors, where indicated, which comply with SDI 111, with blades or baffles formed of **0.020-inch- (0.5-mm-)** thick, cold-rolled steel sheet set into **0.032-inch- (0.8-mm-)** thick steel frame.
 1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
- B. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.2 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.

- a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
 - b. Install frames with removable stops located on secure side of opening.
2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
 3. Floor Anchors: Secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 4. Solidly pack mineral-fiber insulation inside frames.
 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
 6. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
 - a. Squareness: Plus or minus **1/16 inch (1.6 mm)**, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus **1/16 inch (1.6 mm)**, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus **1/16 inch (1.6 mm)**, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
- D. Glazing: Comply with installation requirements in Section 08 8000 "Glazing" and with hollow-metal manufacturer's written instructions.

3.3 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 08 1113

SECTION 08 3113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Access doors and frames.

1.3 ALLOWANCES

- A. Access doors and frames are part of an access door and frame allowance.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details material descriptions, dimensions of individual components and profiles, and finishes.
- B. Product Schedule: For access doors and frames.

1.5 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of applicable room name and number in which access door is located.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES

- A. Flush Access Doors with Exposed Flanges:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Activar Construction Products Group, Inc. - JL Industries.

- b. [ACUDOR Products, Inc.](#)
 - c. [Larsens Manufacturing Company.](#)
 - d. [Milcor; a division of Hart & Cooley, Inc.](#)
 - e. [Nystrom.](#)
- 2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
 - 3. Optional Features: Piano hinges.
 - 4. Locations: Wall, where required to access concealed plumbing and electrical connections.
 - 5. Door Size: 16 inches (40 cm) square.
 - 6. Stainless Steel Sheet for Door: Nominal 0.062 inch (1.59 mm), 16 gage, ASTM A480/A480M No. 4 finish.
 - 7. Frame Material: Same material, thickness, and finish as door.
 - 8. Latch and Lock: Cam latch, screwdriver operated.
 - 9. Location: Where required to access concealed plumbing and concealed electrical connections.

2.2 MATERIALS

- A. Stainless Steel Plate, Sheet, and Strip: ASTM A240/A240M or ASTM A666, Type 304. Remove tool and die marks and stretch lines, or blend into finish.
- B. Stainless Steel Flat Bars: ASTM A666, Type 304. Remove tool and die marks and stretch lines, or blend into finish.
- C. Frame Anchors: Same material as door face.
- D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.3 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
- D. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.

2.4 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Stainless Steel Finishes:
 - 1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
 - 2. Polished Finish: ASTM A480/A480M No. 4 finish. Grind and polish surfaces to produce uniform finish, free of cross scratches.
 - a. Run grain of directional finishes with long dimension of each piece.
 - b. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 08 3113

SECTION 08 5113 - ALUMINUM WINDOWS

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 aluminum windows for exterior locations.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
- B. Shop Drawings: For aluminum windows.
 - 1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.
- C. Samples: For each exposed product and for each color specified, **2 by 4 inches (50 by 100 mm)** in size.
- D. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For manufacturer's warranties.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to meet performance requirements.
 - b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
 - c. Faulty operation of movable sash and hardware.
 - d. Deterioration of materials and finishes beyond normal weathering.
 - e. Failure of insulating glass.
 - 2. Warranty Period:
 - a. Window: 10 years from date of Substantial Completion.
 - b. Glazing Units: Five years from date of Substantial Completion.
 - c. Aluminum Finish: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
 - 1. Window Certification: AAMA certified with label attached to each window.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
 - 1. Minimum Performance Class: FW.
 - 2. Minimum Performance Grade: HC40.

- C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of **0.46 Btu/sq. ft. x h x deg F (2.63 W/sq. m x K)**.
- D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.40.
- E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45.
- F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing 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 Change: **120 deg F (67 deg C)** ambient; **180 deg F (100 deg C)** material surfaces.

2.3 ALUMINUM WINDOWS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Milgard Manufacturing, LLC, Series 710S or comparable product by one of the following:
 - 1. Boyd Aluminum.
 - 2. Kawneer North America, an Arconic company.
 - 3. Oldcastle BuildingEnvelope (OBE); CRH Americas.
- B. Types: Provide the following types in locations indicated on Drawings:
 - 1. Fixed.
- C. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
 - 1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
- D. Insulating-Glass Units: ASTM E2190.
 - 1. Glass: ASTM C1036, Type 1, Class 1, q3.
 - a. Tint: Clear.
 - 2. Lites: Two.
 - 3. Filling: Fill space between glass lites with air.
 - 4. Low-E Coating: Sputtered on second surface.
- E. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

- F. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.
 - 1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.
- G. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
- H. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
 - 1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 ACCESSORIES

- A. Subsills: Thermally broken, extruded-aluminum subsills in configurations indicated on Drawings.

2.5 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
- B. Glaze aluminum windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- E. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.7 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.
 - 1. Color: Dark bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Testing Services: Testing and inspecting of installed windows shall take place as follows:
 1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.
 2. Air-Infiltration Testing:
 - a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
 - b. Allowable Air-Leakage Rate: 1.5 times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.
 3. Water-Resistance Testing:
 - a. Test Pressure: Two-thirds times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
 - b. Allowable Water Infiltration: No water penetration.
 4. Testing Extent: One window of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows shall be tested after perimeter sealants have cured.
 5. Test Reports: Prepared according to AAMA 502.
- C. Windows will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.4 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.
- B. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
 1. Keep protective films and coverings in place until final cleaning.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 08 5113

SECTION 08 7100 – DOOR HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Mechanical and electrified door hardware for:
 - a. Swinging doors.
 - b. Sliding doors.
 - c. Gates.
2. Electronic access control system components
3. Field verification, preparation and modification of existing doors and frames to receive new door hardware.

B. Section excludes:

1. Windows
2. Cabinets (casework), including locks in cabinets
3. Signage
4. Toilet accessories
5. Overhead doors

C. Related Sections:

1. Division 01 Section "Alternates" for alternates affecting this section.
2. Division 06 Section "Rough Carpentry"
3. Division 06 Section "Finish Carpentry"
4. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
5. Division 08 Sections:
 - a. "Metal Doors and Frames"
 - b. "Flush Wood Doors"
 - c. "Stile and Rail Wood Doors"
 - d. "Interior Aluminum Doors and Frames"
 - e. "Aluminum-Framed Entrances and Storefronts"
 - f. "Stainless Steel Doors and Frames"
 - g. "Special Function Doors"
 - h. "Entrances"
6. Division 09 sections for touchup, finishing or refinishing of existing openings modified by this section.

1.02 REFERENCES

A. UL - Underwriters Laboratories

1. UL 10B - Fire Test of Door Assemblies
2. UL 10C - Positive Pressure Test of Fire Door Assemblies
3. UL 1784 - Air Leakage Tests of Door Assemblies
4. UL 305 - Panic Hardware

B. DHI - Door and Hardware Institute

1. Sequence and Format for the Hardware Schedule
2. Recommended Locations for Builders Hardware
3. Keying Systems and Nomenclature
4. Installation Guide for Doors and Hardware

C. NFPA – National Fire Protection Association

1. NFPA 70 – National Electric Code
2. NFPA 80 – 2016 Edition – Standard for Fire Doors and Other Opening Protectives
3. NFPA 101 – Life Safety Code
4. NFPA 105 – Smoke and Draft Control Door Assemblies
5. NFPA 252 – Fire Tests of Door Assemblies

D. ANSI - American National Standards Institute

1. ANSI A117.1 – 2017 Edition – Accessible and Usable Buildings and Facilities
2. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties
3. ANSI/BHMA A156.28 - Recommended Practices for Keying Systems
4. ANSI/WDMA I.S. 1A - Interior Architectural Wood Flush Doors
5. ANSI/SDI A250.8 - Standard Steel Doors and Frames

1.03 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 Submittal Procedures.
2. Prior to forwarding submittal:
 - a. Comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
 - b. Review drawings and Sections from related trades to verify compatibility with specified hardware.
 - c. Highlight, encircle, or otherwise specifically identify on submittals: deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.

B. Action Submittals:

1. Product Data: Submit technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.

2. Samples for Verification: If requested by Architect, submit production sample of requested door hardware unit in finish indicated and tagged with full description for coordination with schedule.
 - a. Samples will be returned to supplier. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
3. Door Hardware Schedule:
 - a. Submit concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate fabrication of other work critical in Project construction schedule.
 - b. Submit with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule published by DHI.
 - c. Indicate complete designations of each item required for each opening, include:
 - 1) Door Index: door number, heading number, and Architect's hardware set number.
 - 2) Quantity, type, style, function, size, and finish of each hardware item.
 - 3) Name and manufacturer of each item.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each hardware set cross-referenced to indications on Drawings.
 - 6) Explanation of all abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for hardware.
 - 8) Door and frame sizes and materials.
 - 9) Degree of door swing and handing.
 - 10) Operational Description of openings with electrified hardware covering egress, ingress (access), and fire/smoke alarm connections.
4. Key Schedule:
 - a. After Keying Conference, provide keying schedule that includes levels of keying, explanations of key system's function, key symbols used, and door numbers controlled.
 - b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
 - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
 - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
 - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion. Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
 - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.
5. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory or shop prepared for door hardware installation.

C. Informational Submittals:

1. Provide Qualification Data for Supplier, Installer and Architectural Hardware Consultant.
 2. Provide Product Data:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
 - b. Include warranties for specified door hardware.
- D. Closeout Submittals:
1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Factory order acknowledgement numbers (for warranty and service)
 - d. Name, address, and phone number of local representative for each manufacturer.
 - e. Parts list for each product.
 - f. Final approved hardware schedule edited to reflect conditions as installed.
 - g. Final keying schedule
 - h. Copies of floor plans with keying nomenclature
 - i. Copy of warranties including appropriate reference numbers for manufacturers to identify project.
 - j. As-installed wiring diagrams for each opening connected to power, both low voltage and 110 volts.
- E. Inspection and Testing:
1. Submit a written report of the results of functional testing and inspection for fire door assemblies, in compliance with NFPA 80.
 - a. Written report to be provided to the Owner and be made available to the Authority Having Jurisdiction (AHJ).
 - b. Report to include the door number for each fire door assembly, door location, door and frame material, fire rating, and summary of deficiencies.
 2. Submit a written report of the results of functional testing and inspection for required egress door assemblies, in compliance with NFPA 101.
 - a. Written report to be provided to the Owner and be made available to the Authority Having Jurisdiction (AHJ).
 - b. Report to include the door number for each required egress door assembly, door location, door and frame material, fire rating, and summary of deficiencies.

1.04 QUALITY ASSURANCE

- A. Qualifications and Responsibilities:
1. Supplier: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) or Door Hardware Consultant (DHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.

- a. Warehousing Facilities: In Project's vicinity.
 - b. Scheduling Responsibility: Preparation of door hardware and keying schedules.
 - c. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies like those indicated for this Project.
 - d. Coordination Responsibility: Assist in coordinating installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.
 - 1) Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.
2. Installer: Qualified tradesperson skilled in the application of commercial grade hardware with experience installing door hardware similar in quantity, type, and quality as indicated for this Project.
 3. Architectural Hardware Consultant: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
 - a. For door hardware: DHI certified AHC or DHC.
 - b. Can provide installation and technical data to Architect and other related subcontractors.
 - c. Can inspect and verify components are in working order upon completion of installation.
 - d. Capable of producing wiring diagram and coordinating installation of electrified hardware with Architect and electrical engineers.
 4. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
- B. Certifications:
1. Fire-Rated Door Openings:
 - a. Provide door hardware for fire-rated openings that complies with NFPA 80 and requirements of authorities having jurisdiction.
 - b. Provide only items of door hardware that are listed products tested by Underwriters Laboratories, Intertek Testing Services, or other testing and inspecting organizations acceptable to authorities having jurisdiction for use on types and sizes of doors indicated, based on testing at positive pressure and according to NFPA 252 or UL 10C and in compliance with requirements of fire-rated door and door frame labels.
 2. Smoke and Draft Control Door Assemblies:
 - a. Provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105
 - b. Comply with the maximum air leakage of 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) at tested pressure differential of 0.3-inch wg (75 Pa) of water.
 3. Accessibility Requirements:
 - a. Comply with governing accessibility regulations cited in "REFERENCES" article 087100, 1.02.D3 herein for door hardware on doors in an accessible route. This project must comply with all Federal Americans with Disability Act regulations and all Local Accessibility Regulations.

C. Pre-Installation Meetings

1. Keying Conference

- a. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - 1) Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - 2) Preliminary key system schematic diagram.
 - 3) Requirements for key control system.
 - 4) Requirements for access control.
 - 5) Address for delivery of keys.

2. Pre-installation Conference

- a. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- b. Inspect and discuss preparatory work performed by other trades.
- c. Inspect and discuss electrical roughing-in for electrified door hardware.
- d. Review sequence of operation for each type of electrified door hardware.
- e. Review required testing, inspecting, and certifying procedures.
- f. Review questions or concerns related to proper installation and adjustment of door hardware.

3. Electrified Hardware Coordination Conference:

- a. Prior to ordering electrified hardware, schedule and hold meeting to coordinate door hardware with security, electrical, doors and frames, and other related suppliers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site. Promptly replace products damaged during shipping.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package. Deliver each article of hardware in manufacturer's original packaging.
- C. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
- D. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- E. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- F. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.

1.06 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Security: Coordinate installation of door hardware, keying, and access control with Owner's security consultant.
- D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.
- E. Existing Openings: Where existing doors, frames and/or hardware are to remain, field verify existing functions, conditions and preparations and coordinate to suit opening conditions and to provide proper door operation.

1.07 WARRANTY

- A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within published warranty period.
 - 1. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.
 - 2. Warranty Period: Beginning from date of Substantial Completion, for durations indicated in manufacturer's published listings.
 - a. Mechanical Warranty
 - 1) Locks
 - a) Schlage L Series: 3 year
 - 2) Closers
 - a) LCN 4000 Series: 30 year

1.08 MAINTENANCE

- A. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.
- B. Turn over unused materials to Owner for maintenance purposes.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Approval of manufacturers and/or products other than those listed as “Scheduled Manufacturer” or “Acceptable Manufacturers” in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.
- B. Approval of products from manufacturers indicated in “Acceptable Manufacturers” is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer’s product.
- C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

2.02 MATERIALS

- A. Fasteners
 - 1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
 - 2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
 - 3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru bolts are required.
 - 4. Install hardware with fasteners provided by hardware manufacturer.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
 - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.03 HINGES

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product:
 - a. Ives 5BB series
- B. Requirements:
 - 1. Provide hinges conforming to ANSI/BHMA A156.1.
 - 2. Provide five knuckle, ball bearing hinges.

3. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high
4. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
5. 2 inches or thicker doors:
 - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
6. Adjust hinge width for door, frame, and wall conditions to allow proper degree of opening.
7. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
8. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
9. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins
10. Provide hinges with electrified options as scheduled in the hardware sets. Provide with enough wire gage to accommodate electric function of specified hardware. Locate electric hinge at second hinge from bottom or nearest to electrified locking component. Provide mortar guard for each electrified hinge specified.

2.04 DEADLOCKS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

- a. Schlage L400 series

B. Requirements:

1. Provide mortise deadlock series conforming to ANSI/BHMA A156.
2. Cylinders: Refer to "KEYING" article, herein.
3. Provide deadlocks with standard 2-3/4 inches (70 mm) backset. Provide deadbolt with full 1-inch (25 mm) throw, constructed of stainless steel.
4. Provide manufacturer's standard strike.

2.05 KEYING

A. Match Owner's existing key system.

2.06 KEY CONTROL SYSTEM

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Telkee

B. Requirements:

1. Provide key control system, including envelopes, labels, tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by system manufacturer, with capacity for 150% of number of locks required for Project.
 - a. Provide complete cross index system set up by hardware supplier, and place keys on markers and hooks in cabinet as determined by final key schedule.
 - b. Provide hinged-panel type cabinet for wall mounting.

2.07 DOOR CLOSERS

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product:

- a. LCN 4040XP series

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with high strength cast iron cylinder, and full complement bearings at shaft.
3. Cylinder Body: 1-1/2-inch (38 mm) diameter with 5/8-inch (16 mm) diameter double heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Provide closers with solid forged steel main arms and factory assembled heavy-duty forged forearms for parallel arm closers.
8. Pressure Relief Valve (PRV) Technology: Not permitted.
9. Finish for Closer Cylinders, Arms, Adapter Plates, and Metal Covers: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117, or has special rust inhibitor (SRI).
10. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.08 DOOR TRIM

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Ives.

B. Requirements:

1. Provide push plates, push bars, pull plates, pulls, and hands-free reversible door pulls with diameter and length as scheduled.

2.09 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Ives

B. Requirements:

1. Provide protection plates with a minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes plates 2 inches (51 mm) less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch (25 mm) less width of door on pairs without a mullion or edge guards.
3. At fire rated doors, provide protection plates over 16 inches high with UL label.

2.10 DOOR STOPS AND HOLDERS

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Ives

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide concave type where lockset has a push button or thumbturn.
2. Where a wall stop cannot be used, provide universal floor stops.
3. Where wall or floor stop cannot be used, provide overhead stop.
4. Provide roller bumper where doors open into each other and overhead stop cannot be used.

2.11 THRESHOLDS, SEALS, DOOR SWEEPS, AUTOMATIC DOOR BOTTOMS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer:

- a. Zero International

B. Requirements:

1. Provide thresholds, weather-stripping, and gasketing systems as specified and per architectural details. Match finish of other items.
2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.
4. Size thresholds 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width unless otherwise specified in the hardware sets or detailed in the drawings.

2.12 FINISHES

- A. Finish: As Scheduled.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance. Verify doors, frames, and walls have been properly reinforced for hardware installation.
- B. Field verify existing doors and frames receiving new hardware and existing conditions receiving new openings. Verify that new hardware is compatible with existing door and frame preparation and existing conditions.
- C. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- D. Submit a list of deficiencies in writing and proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 2. Custom Steel Doors and Frames: HMMA 831.
 3. Interior Architectural Wood Flush Doors: ANSI/WDMA I.S. 1A
 4. Installation Guide for Doors and Hardware: DHI TDH-007-20

- B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated.
- H. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- I. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- J. Closer/holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- K. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- L. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- M. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- N. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- O. Door Bottoms and Sweeps: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 FIELD QUALITY CONTROL

- A. Inspection and Testing:
 - 1. Provide functional testing and inspection of fire door assemblies by a qualified person in accordance with NFPA 80.
 - a. Schedule fire door assembly inspection within 90 days of Substantial Completion of the Project.
 - b. Submit a signed, written final report as specified in Paragraph 1.03.E.1.

- c. Correct all deficiencies and schedule a reinspection of fire door assemblies noted as deficient on the inspection report.
 - d. Inspector to reinspect fire door assemblies after repairs are made.
2. Provide inspection of required egress door assemblies by a qualified person in accordance with NFPA 101.
 - a. Schedule egress door assembly inspection within 90 days of Substantial Completion of the Project for the required openings.
 - b. Submit a signed, written final report as specified in Paragraph 1.03.E.2.
 - c. Correct all deficiencies and schedule a reinspection of egress door assemblies noted as deficient on the inspection report.
 - d. Inspector to reinspect required egress door assemblies after repairs are made.

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. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.05 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items per manufacturer's instructions to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.06 DOOR HARDWARE SCHEDULE

- A. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Discrepancies, conflicting hardware, and missing items are to be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application.

- C. Hardware items are referenced in the following hardware schedule. Refer to the above specifications for special features, options, cylinders/keying, and other requirements.
- D. Hardware Sets: is indicated in the Drawings.

END OF SECTION 08 7100

SECTION 08 9119 - FIXED LOUVERS

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. Fixed extruded-aluminum louvers.

1.3 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing according to AMCA 540.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
 - 1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
 - 2. Show mullion profiles and locations.

- C. Samples: For each type of metal finish required.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- B. Sample Warranties: For manufacturer's special warranties.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 WARRANTY

- A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
 - 1. Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- B. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- D. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal, Wind-Driven-Rain-Resistant Louver:
1. Basis-of-Design Product: Subject to compliance with requirements, provide Ruskin Company; EME220DD Wind-Driven Rain Resistant Stationary Louver or a comparable product by one of the following:
 - a. Construction Specialties, Inc.
 - b. Industrial Louvers Inc.
 - c. United Enertech.
 2. Louver Depth: 2 inches (50 mm).
 3. Frame and Blade Nominal Thickness: Not less than 0.040 inch (1.02 mm).
 4. Louver Performance Ratings:
 - a. Free Area: Not less than 6.0 sq. ft. (0.56 sq. m) for 48-inch- (1220-mm-) wide by 48-inch- (1220-mm-) high louver.
 - b. Air Performance: Not more than 0.10-inch wg (25-Pa) static pressure drop at 600-fpm (3.0-m/s) free-area velocity.
 - c. Wind-Driven Rain Performance: Not less than 95 percent effectiveness when subjected to a rainfall rate of 8 inches (200 mm) per hour and a wind speed of 50 mph (22.4 m/s) at a core-area intake velocity of 300 fpm (1.5 m/s).
 5. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
 - 1. Screen Location for Fixed Louvers: Interior face.
 - 2. Screening Type: Bird screening.
- B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of **6 inches (150 mm)** from each corner and at **12 inches (300 mm)** o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
 - 1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
 - 2. Finish: Same finish as louver frames to which louver screens are attached.
 - 3. Type: Non-rewirable, U-shaped frames.
- D. Louver Screening for Aluminum Louvers:
 - 1. Bird Screening: Aluminum, **1/2-inch- (13-mm-)** square mesh, **0.063-inch (1.60-mm)** wire.

2.5 MATERIALS

- A. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: **ASTM B209 (ASTM B209M)**, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
 - 1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
 - 2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
 - 3. For fastening galvanized steel, use hot-dip-galvanized-steel or 300 series stainless-steel fasteners.
 - 4. For fastening stainless steel, use 300 series stainless-steel fasteners.
 - 5. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless-steel components, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing according to ASTM E488/E488M conducted by a qualified testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
 - 1. Frame Type: Channel unless otherwise indicated.
- D. Include supports, anchorages, and accessories required for complete assembly.
- E. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or **72 inches (1830 mm)** o.c., whichever is less.
 - 1. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades, so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
 - 2. Exterior Corners: Prefabricated corner units with mitered blades with concealed close-fitting splices and with semirecessed mullions at corners.
- F. Provide subsills made of same material as louvers or extended sills for recessed louvers.
- G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.7 ALUMINUM FINISHES

- A. Finish louvers after assembly.
- B. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.
 - 1. Color: Dark bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and openings, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 07 9200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
 - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 08 9119

SECTION 09 9113 - EXTERIOR PAINTING

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. Primers.
 - 2. Finish coatings.
- B. Related Requirements:
 - 1. Section 05 1200 "Structural Steel Framing" for shop priming of metal substrates.
 - 2. Section 05 5000 "Metal Fabrications" for shop priming metal fabrications.
 - 3. Section 09 9300 "Staining and Transparent Finishing" for surface preparation and application of wood stains and transparent finishes on exterior wood substrates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include preparation requirements and application instructions.
 - 2. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, **8 inches (200 mm)** square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product Schedule: Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Behr Paint Company; Behr Process Corporation.
 2. Benjamin Moore & Co.
 3. Kelly-Moore Paint Company Inc.
 4. PPG Paints.
 5. Pratt & Lambert.
 6. Sherwin-Williams Company (The).
 7. Valspar Corporation (The).
- B. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 PAINT PRODUCTS, GENERAL

- A. Material Compatibility:
 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by topcoat manufacturer for use in paint system and on substrate indicated.
- B. Colors: As indicated in a color schedule.

1. 30 percent of surface area will be painted with deep tones.

2.3 PRIMERS

- A. Exterior, Alkali-Resistant, Water-Based Primer: Pigmented, water-based primer formulated for use on alkaline surfaces, such as exterior plaster, vertical concrete, and masonry.
- B. Exterior, Alkyd/Oil Wood Primer: Alkyd/oil-based primer that is resistant to extractive bleeding when applied to wood substrates with less than 15 percent moisture content; formulated for sag, mold, and microbial resistance; for hiding stains; and for use on exterior wood subject to extractive bleeding.
- C. Zinc-Rich, Inorganic Primer: Corrosion-resistant, inorganic-based, zinc-rich primer formulated for use on prepared steel subject to severe industrial or marine environments.
- D. Alkyd Metal Primer: Corrosion-resistant, solvent-based, alkyd primer formulated for use on prepared ferrous metals subject to industrial and light marine environments.
- E. Water-Based, Galvanized-Metal Primer: Corrosion-resistant, pigmented, acrylic primer; formulated for use on cleaned/etched, exterior, galvanized metal to prepare it for subsequent water-based coatings.

2.4 FINISH COATINGS

- A. Exterior Latex Paint, Low Sheen: Water-based, pigmented coating; formulated for alkali, mold, microbial, and water resistance and for use on exterior surfaces, such as portland cement plaster, concrete, and primed wood.
 1. Gloss and Sheen Level: Gloss of 10 to 35 units at 60 degrees and minimum sheen of 10 units at 85 degrees when tested in accordance with ASTM D523.
- B. Exterior, Water-Based, Light Industrial Coating, Low Sheen: Corrosion-resistant, water-based, pigmented, emulsion coating formulated for resistance to blocking (sticking of two painted surfaces), water, alkalis, moderate abrasion, and mild chemical exposure and for use on exterior, primed, wood and metal surfaces.
 1. Gloss and Sheen Level: Gloss of 10 to 25 units at 60 degrees and sheen of 10 to 35 units at 85 degrees when tested in accordance with ASTM D523.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Fiber-Cement Board: 12 percent.
 2. Wood: 15 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.
- D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer[,] but not less than the following:
1. SSPC-SP 2.
- E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- G. Wood Substrates:
1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
 2. Sand surfaces that will be exposed to view, and remove sanding dust.
 3. Prime edges, ends, faces, undersides, and backsides of wood.
 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 INSTALLATION

- A. Apply paints in accordance with manufacturer's written instructions.
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 - 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in the Exterior Painting Schedule may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed to view:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 - 1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
 - 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 - 3. Allow empty paint cans to dry before disposal.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

- A. Steel and Iron Substrates:
 - 1. Water-Based, Light Industrial Coating System:
 - a. Prime Coat: Zinc-rich, inorganic primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, low sheen.
- B. Galvanized-Metal Substrates:
 - 1. Water-Based, Light Industrial Coating System:
 - a. Prime Coat: Water-based, galvanized-metal primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior, water-based, light industrial coating, low sheen.
- C. Exposed Wood-Framing Substrates:
 - 1. Latex over Alkyd Primer System:
 - a. Prime Coat: Exterior, alkyd/oil wood primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, low sheen.
- D. Cementitious Composition Board Substrates: Trim and Panels.

1. Latex over Alkyd Primer System:
 - a. Prime Coat: Exterior, alkali-resistant, water-based primer.
 - b. Intermediate Coat: Matching topcoat.
 - c. Topcoat: Exterior latex paint, low sheen.

END OF SECTION 09 9113

3.7 EXTERIOR COLOR SCHEDULE

A. Steel and Iron Substrates:

1. Exposed Structural Steel:
 - a. Paint to match Sherwin Williams SW 7675 "Sealskin."
2. Exposed Miscellaneous Steel:
 - a. Paint to match Sherwin Williams SW 7675 "Sealskin."

B. Galvanized-Metal Substrates:

1. Exposed Structural Steel:
 - a. Paint to match Sherwin Williams SW 7675 "Sealskin."
2. Exposed Miscellaneous Steel:
 - a. Paint to match Sherwin Williams SW 7675 "Sealskin."
3. Exterior Doors:
 - a. Paint to match Sherwin Williams SW 7675 "Sealskin."
4. Electrical Meter Can, Switchgear, Panels, and Exposed Conduit:
 - a. Paint to match Sherwin Williams SW 7675 "Sealskin."
5. Exposed Loose Lintels:
 - a. Paint to match Sherwin Williams SW 7675 "Sealskin."
6. Exposed Access Panels:
 - a. Paint to match Sherwin Williams SW 7675 "Sealskin."
7. Bollards:
 - a. "Yellow" complying with OSHA 1910.144(a)(3).

C. Exposed Wood-Framing Substrates:

1. Exposed Tongue & Groove Wood Deck:

- a. Clear sealer, as specified in Section 09 9300 "Staining and Transparent Finishing."

2. Wood Trim:

- a. Paint to match Sherwin Williams SW 7675 "Sealskin."

D. Cementitious Composition Board Substrates: Trim and Panels.

1. Fiber Cement Panels and Trim:

- a. Paint to match Sherwin Williams SW 7675 "Sealskin."

END OF SECTION 09 9113

SECTION 09 9123 - INTERIOR PAINTING

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. Primers.
 - 2. Water-based finish coatings.
 - 3. Floor sealers and paints.
- B. Related Requirements:
 - 1. Section 05 5000 "Metal Fabrications" for shop priming metal fabrications.
 - 2. Section 09 9300 "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
 - 1. Include preparation requirements and application instructions.
 - 2. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches (200 mm) square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product Schedule: Use same designations indicated on Drawings and in the Interior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Behr Paint Company; Behr Process Corporation.
 2. Benjamin Moore & Co.
 3. Kelly-Moore Paint Company Inc.
 4. PPG Paints.
 5. Pratt & Lambert.
 6. Sherwin-Williams Company (The).
 7. Valspar Corporation (The).
- B. Source Limitations: Obtain each paint product from single source from single manufacturer.

2.2 PAINT PRODUCTS, GENERAL

- A. Material Compatibility:
 1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. Colors: As selected by Architect from manufacturer's full range.

2.3 PRIMERS

- A. Interior/Exterior Latex Block Filler: Water-based, high-solids, emulsion coating formulated to bridge and fill porous surfaces of exterior concrete masonry units in preparation for specified subsequent coatings.
- B. Alkali-Resistant, Water-Based Primer: Water-based primer formulated for use on alkaline surfaces, such as plaster, vertical concrete, and masonry.
- C. Interior Latex Primer Sealer: Water-based latex sealer used on new interior plaster, concrete, and gypsum wallboard surfaces.
- D. Alkyd Quick-Dry Primer for Metal: Corrosion-resistant, solvent-based, modified-alkyd primer; lead and chromate free; formulated for quick-drying capabilities and for use on cleaned, interior steel surfaces.
- E. Water-Based Galvanized-Metal Primer: Corrosion-resistant, acrylic primer; formulated for use on cleaned/etched, exterior, galvanized metal to prepare it for subsequent water-based coatings.

2.4 WATER-BASED FINISH COATS

- A. Interior, Latex, High-Performance Architectural Coating, Satin: High-performance architectural latex coating providing a significantly higher level of performance than conventional latex paints in the areas of scrub resistance, burnish resistance, and ease of stain removal.
 - 1. Gloss Level: Gloss of 10 to 25 units at 60 degrees when tested in accordance with ASTM D523.

2.5 FLOOR SEALERS AND PAINTS

- A. Solvent-Based Concrete Floor Sealer: Clear, acrylic, solvent-based sealer formulated for oil, gasoline, alkali, and water resistance and for use on concrete traffic surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Masonry (Clay and CMUs): 12 percent.
 - 3. Wood: 15 percent.

4. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer[,] but not less than the following:
 1. SSPC-SP 2.
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 INSTALLATION

- A. Apply paints according to manufacturer's written instructions.
 1. Use applicators and techniques suited for paint and substrate indicated.
 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 1. Paint the following work where exposed:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
 2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.
 - 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 - 2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
 - 1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
 - 2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
 - 3. Allow empty paint cans to dry before disposal.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Traffic Surfaces:
 - 1. Solvent-Based Concrete Floor Sealer System:
 - a. First Coat: Matching topcoat.
 - b. Topcoat: Solvent-based concrete floor sealer.
- B. CMU Substrates:
 - 1. High-Performance Architectural Latex System:
 - a. Block Filler: Interior/exterior latex block filler.
 - b. Prime Coat: Alkali-resistant, water-based primer.
 - c. Topcoat: Interior, latex, high-performance architectural coating, satin.

C. Steel Substrates:

1. High-Performance Architectural Latex System:
 - a. Prime Coat: Alkyd anticorrosive primer.
 - b. Topcoat: Topcoat: Interior, latex, high-performance architectural coating, satin.

D. Galvanized-Metal Substrates:

1. High-Performance Architectural Latex System:
 - a. Prime Coat:
 - b. Topcoat: Interior, latex, high-performance architectural coating, satin.

E. Fiber Cement Board Substrates:

1. High-Performance Architectural Latex System:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Topcoat: Interior, latex, high-performance architectural coating, satin.

F. Finish Carpentry: Wood trim.

1. High-Performance Architectural Latex System:
 - a. Prime Coat: Interior latex primer sealer.
 - b. Topcoat: Interior, latex, high-performance architectural coating, satin.

END OF SECTION 09 9123

SECTION 09 9300 - STAINING AND TRANSPARENT FINISHING

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. Transparent finishes.
- B. Related Requirements:
 - 1. Section 09 9123 "Interior Painting" for stains and transparent finishes on concrete floors.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
 - 2. Include preparation requirements and application instructions.
 - 3. Indicate VOC content.
- B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of exposed finish.
- C. Samples for Verification: Sample for each type of finish system and in each color and gloss of finish required on representative samples of actual wood substrates.
 - 1. Size: 8 inches (200 mm) square.
 - 2. Apply coats on Samples in steps to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- D. Product List: Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Stains and Transparent Finishes: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply finishes when relative humidity exceeds 85 percent, at temperatures of less than 5 deg F (3 deg C) above the dew point, or to damp or wet surfaces.
- C. Do not apply exterior finishes in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Benjamin Moore & Co.
 2. PPG Paints.
 3. Pratt & Lambert.
 4. Sherwin-Williams Company (The).

2.2 SOURCE LIMITATIONS

- A. Source Limitations: Obtain each coating product from single source from single manufacturer.

2.3 MATERIALS, GENERAL

- A. Material Compatibility:
 1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2.4 TRANSPARENT FINISHES

- A. Varnish with UV Inhibitor, Exterior, Semigloss: Solvent-based, alkyd-type, clear semigloss varnish stabilized against UV deterioration for exterior wood surfaces.
 - 1. Gloss Level: Gloss of 35 to 70 units at 60 degrees when tested in accordance with ASTM D523.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with finish application only after unsatisfactory conditions have been corrected.
 - 1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
 - 1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- B. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.
 - 1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
 - 2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by finish manufacturer.
- C. Exterior Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Prime edges, ends, faces, undersides, and backsides of wood.

3. Countersink steel nails, if used, and fill with putty or plastic wood filler tinted to final color. Sand smooth when dried.

3.3 APPLICATION

- A. Apply finishes according to manufacturer's written instructions.
 1. Use applicators and techniques suited for finish and substrate indicated.
 2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
 3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 EXTERIOR WOOD-FINISH-SYSTEM SCHEDULE

- A. Wood Substrates, Exposed Framing:
 1. Varnish System:
 - a. Prime Coat: Varnish matching topcoat.
 - b. First Intermediate Coat: Varnish matching topcoat.
 - c. Topcoat: Varnish, with UV inhibitor, exterior, semigloss.

3.6 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

- A. Wood Substrates, Exposed Framing:
 1. Varnish System:
 - a. Prime Coat: Varnish matching topcoat.

- b. Topcoat: Varnish, with UV inhibitor, exterior, semigloss.

END OF SECTION 09 9300

SECTION 10 1423 - PANEL SIGNAGE

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. Panel signs, where required by the Authority Having Jurisdiction.
 - 2. Field-applied, vinyl-character signs, where required by the Authority Having Jurisdiction.
- B. Related Requirements:
 - 1. Section 01 5000 "Temporary Facilities and Controls" for temporary Project identification signs and for temporary informational and directional signs.
 - 2. Section 22 0553 "Identification for Plumbing Piping and Equipment" for labels, tags, and nameplates for plumbing systems and equipment.
 - 3. Section 23 0553 "Identification for HVAC Piping and Equipment" for labels, tags, and nameplates for HVAC systems and equipment.
 - 4. Section 26 0553 "Identification for Electrical Systems" for labels, tags, and nameplates for electrical equipment.
 - 5. Section 26 5213 "Emergency and Exit Lighting" for illuminated, self-luminous, and photoluminescent exit sign units.

1.3 ALLOWANCES

- A. Allowances for signage are specified in Section 01 2100 "Allowances."

1.4 DEFINITIONS

- A. Accessible: In accordance with the Texas Accessibility Standards, current edition.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For panel signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.

3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
1. Include representative Samples of available typestyles and graphic symbols.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
1. Panel Signs: Full-size Sample.
 2. Field-Applied, Vinyl-Character Signs: Full-size Sample of characters on glass.
 3. Full-size Samples, if approved, will be returned to Contractor for use in Project.
- E. Product Schedule: For panel signs. Use same designations indicated on Drawings or specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the Texas Accessibility Standards, current edition.

2.2 PANEL SIGNS

- A. Panel Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
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. Cosco.
 - b. Inpro Corporation.
 - c. Seton Identification Products; a Brady Corporation company.
 - d. Signs & Decal Corp.
 - e. Vista System.

2. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: Manufacturer's standard for size of sign.
 - b. Surface-Applied, Flat Graphics: Applied vinyl film.
 - c. Surface-Applied, Raised Graphics: Applied polymer characters and Braille.
3. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: Square cut.
 - b. Corner Condition in Elevation: Square.
4. Mounting: Surface mounted to wall with two-face tape.
5. Text and Typeface: Accessible raised characters and Braille. Finish raised characters to contrast with background color, and finish Braille to match background color.
6. Flatness Tolerance: Sign shall remain flat or uniformly curved under installed conditions as indicated on Drawings and within a tolerance of plus or minus **1/16 inch (1.5 mm)** measured diagonally from corner to corner.

2.3 FIELD-APPLIED, VINYL-CHARACTER SIGNS

- A. Field-Applied, Vinyl-Character Sign: Prespaced characters die cut from **3- to 3.5-mil (0.076- to 0.089-mm)** thick, weather-resistant vinyl film with release liner on the back and carrier film on the front for on-site alignment and application.
 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. Inpro Corporation.
 - b. Seton Identification Products; a Brady Corporation company.
 2. Size: As required by the Authority Having Jurisdiction.
 3. Substrate: Glass, Doors, or Walls as required by the Authority Having Jurisdiction.
 4. Text and Font: As required by the Authority Having Jurisdiction.

2.4 PANEL-SIGN MATERIALS

- A. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- B. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides.
- C. PVC Sheet: Manufacturer's standard, UV-light stable, PVC plastic.
- D. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.

2.5 ACCESSORIES

- A. Adhesive: As recommended by sign manufacturer.
 - 1. Verify adhesives have a VOC content of 70 g/L or less.
- B. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch (1.14 mm) thick, with adhesive on both sides.

2.6 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Preassemble signs in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
 - 4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 5. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
 - 6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.

2.7 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
 - 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Accessible Signage: Install in locations on walls according to the accessibility standard.
- C. Mounting Methods:
 - 1. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
 - 2. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.
- D. Field-Applied, Vinyl-Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages, and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.
- E. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 10 1423

SECTION 10 2113.19 - PLASTIC TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid-plastic toilet compartments configured as toilet enclosures.
- B. Related Requirements:
 - 1. Section 06 1000 "Rough Carpentry" for blocking.

1.3 COORDINATION

- A. Coordinate requirements for blocking, reinforcing, and other supports concealed within wall.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Solid-plastic toilet compartments:
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.
- B. Shop Drawings: For solid-plastic toilet compartments.
 - 1. Include plans, elevations, sections, details, and attachment details.
 - 2. Show locations of cutouts for compartment-mounted toilet accessories.
 - 3. Show locations of centerlines of toilet fixtures.
 - 4. Show locations of floor drains.
- C. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of toilet compartment material indicated.
 - 1. Include Samples of hardware and accessories involving material and color selection.
- D. Samples for Verification: Actual sample of finished products for each type of toilet compartment indicated.

1. Size: ~~6-inch-~~ (152-mm-) square, of same thickness indicated for Work.
2. Include each type of hardware and accessory.

- E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates:

1. Product Certificates: For each type of toilet compartment by manufacturer.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet compartments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Door Hinges: One hinge(s) with associated fasteners.
2. Latch and Keeper: One latch(es) and keeper(s) with associated fasteners.
3. Door Bumper: One bumper(s) with associated fasteners.
4. Door Pull: One door pull(s) with associated fasteners.
5. Fasteners: 10 fasteners of each size and type.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements, and coordinate before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire Performance: Tested in accordance with, and pass the acceptance criteria of, NFPA 286.
- B. Regulatory Requirements: Comply with applicable provisions in the Texas Accessibility Standards (TAS), 2012 edition for toilet compartments designated as accessible.

2.2 SOLID-PLASTIC TOILET COMPARTMENTS

- 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. AJW Architectural Products.
 2. ASI Accurate Partitions; ASI Group.
 3. Scranton Products.
- B. Toilet-Enclosure Style: Floor anchored.
- C. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene (HDPE) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
1. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum or stainless steel strip fastened to exposed bottom edges of solid-plastic components to hinder malicious combustion.
 2. Color and Pattern: One color and pattern in each room as selected by Architect from manufacturer's full range.
- D. Pilaster Shoes and Sleeves (Caps): Manufacturer's standard design; stainless steel.
- E. Brackets (Fittings):
1. Stirrup Type: Ear or U-brackets, stainless steel.

2.3 HARDWARE AND ACCESSORIES

- A. Hardware and Accessories, Heavy Duty: Manufacturer's heavy-duty operating hardware and accessories.
1. Hinges: Manufacturer's minimum 0.062-inch- (1.59-mm-) thick stainless steel paired, self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees, allowing emergency access by lifting door. Mount with through bolts.
 2. Latch and Keeper: Manufacturer's heavy-duty, surface-mounted, cast-stainless steel latch unit, designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through bolts.
 3. Coat Hook: Manufacturer's heavy-duty combination cast-stainless steel hook and rubber-tipped bumper, sized to prevent inswinging door from hitting compartment-mounted accessories. Mount with through bolts.
 4. Door Bumper: Manufacturer's heavy-duty, rubber-tipped, cast-stainless steel bumper at outswinging doors. Mount with through bolts.
 5. Door Pull: Manufacturer's heavy-duty, cast-stainless steel pull at outswinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through bolts.

- B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with antigrip profile and in manufacturer's standard finish.
- C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 MATERIALS

- A. Aluminum Castings: ASTM B26/B26M.
- B. Aluminum Extrusions: **ASTM B221 (ASTM B221M)**.
- C. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.
- D. Stainless Steel Castings: ASTM A743/A743M.

2.5 FABRICATION

- A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.
- B. Floor-Anchored Units: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment nuts at pilasters for structural connection to floor. Provide shoes at pilasters to conceal anchorage.
- C. Door Size and Swings: Unless otherwise indicated, provide **24-inch- (610-mm-)** wide, inswinging doors for standard toilet compartments and **36-inch- (914-mm-)** wide, outswinging doors with a minimum **32-inch- (813-mm-)** wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.
 - 1. Confirm location and adequacy of blocking and supports required for installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PLASTIC TOILET COMPARTMENTS

- A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.
1. Maximum Clearances:
 - a. Pilasters and Panels: **1/2 inch (13 mm)**.
 - b. Panels and Walls: **1 inch (25 mm)**.
 2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.
 - a. Locate wall brackets, so holes for wall anchors occur in masonry or tile joints.
 - b. Align brackets at pilasters with brackets at walls.
- B. Floor-Anchored Units: Set pilasters with anchors penetrating not less than **2 inches (51 mm)** into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust, so tops of doors are level with tops of pilasters when doors are in closed position.

3.3 ADJUSTING

- A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on inswinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on outswinging doors to return doors to fully closed position.

END OF SECTION 10 2113.19

SECTION 10 2800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Hand dryers.
 - 3. Custodial accessories.

1.3 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Include electrical characteristics.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify accessories using designations indicated.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

1.7 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, visible silver spoilage defects.
 - 2. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Hand Dryers: Manufacturer agrees to repair or replace hand dryers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Structural Performance: Design accessories and fasteners to comply with the following requirements:
 - 1. Grab Bars: Installed units are able to resist **250 lbf (1112 N)** concentrated load applied in any direction and at any point.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Source Limitations: Obtain each type of public-use washroom accessory from single source from single manufacturer.
- B. Toilet Tissue (Jumbo-Roll) Dispenser TA-01:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; B-2892 or a comparable product by one of the following:
 - a. AJW Architectural Products.
 - b. American Specialties Inc.; ASI Group.
 - c. Bradley Corporation.
 - 2. Description: Two-roll unit with sliding panel to expose other roll.
 - 3. Mounting: Surface mounted.
 - 4. Capacity: **9- or 10-inch- (228- or 254-mm-)** diameter rolls.

5. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
6. Lockset: Tumbler type.
7. Refill Indicator: Pierced slots at front.

C. Waste Receptacle TA-02:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; B-2280 or a comparable product by one of the following:
 - a. AJW Architectural Products.
 - b. American Specialties Inc.; ASI Group.
 - c. Bradley Corporation.
2. Mounting: Open top, Freestanding.
3. Minimum Capacity: 21 gallon (79.5 L).
4. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Liner: Reusable vinyl liner.
6. Lockset: Tumbler type for waste receptacle.

D. Soap Dispenser TA-03:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; B-2111 or a comparable product by one of the following:
 - a. AJW Architectural Products.
 - b. American Specialties Inc.; ASI Group.
 - c. Bradley Corporation.
2. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
3. Mounting: Vertically oriented, surface mounted.
4. Capacity: 40 fl-oz (1.2 L).
5. Materials: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
6. Lockset: Tumbler type.
7. Refill Indicator: Window type.

E. Grab Bar TA-04:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc.; B-6806x36 or a comparable product by one of the following:
 - a. AJW Architectural Products.
 - b. American Specialties Inc.; ASI Group.
 - c. Bradley Corporation.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
4. Outside Diameter: 1-1/2 inches (38 mm).
5. Configuration and Length: Straight, 36 inches (914 mm) long.

F. Grab Bar TA-05:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc; B-6806x42 or a comparable product by one of the following:
 - a. AJW Architectural Products.
 - b. American Specialties Inc.; ASI Group.
 - c. Bradley Corporation.
2. Mounting: Flanges with concealed fasteners.
3. Material: Stainless steel, **0.05 inch (1.3 mm)** thick.
 - a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin).
4. Outside Diameter: **1-1/2 inches (38 mm)**.
5. Configuration and Length: Straight, **42 inches (1066 mm)** long.

G. Mirror Unit TA-06:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Bobrick Washroom Equipment, Inc; B-165 2436 or a comparable product by one of the following:
 - a. AJW Architectural Products.
 - b. American Specialties Inc.; ASI Group.
 - c. Bradley Corporation.
2. Frame: Stainless steel channel.
 - a. Corners: Mitered and mechanically interlocked.
3. Size: **24 inches (61 cm)** W by **36 inches (91 cm)** H.
4. Hangers: Manufacturer's standard rigid, tamper and theft resistant.

2.3 HAND DRYERS

A. Source Limitations: Obtain hand dryers from single source from single manufacturer.

B. High-Speed Air Dryer TA-07:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Excel Dryer Inc.; XLERATOR® Hand Dryer or a comparable product by one of the following:
 - a. AJW Architectural Products.
 - b. American Dryer, Inc.
 - c. American Specialties Inc.; ASI Group.
 - d. Bradley Corporation.
 - e. World Dryer Corporation.
2. Description: High-speed, warm-air hand dryer for rapid hand drying.
3. Mounting: Semirecessed.

- a. Protrusion Limit: Installed unit protrudes maximum **4 inches (102 mm)** from wall surface.
 - b. Provide Manufacturer's recess kit.
4. Operation: Infrared-sensor activated with timed power cut-off switch.
- a. Average Dry Time: 8 seconds.
 - b. Automatic Shut Off: At 35 seconds.
5. Maximum Sound Level: 75 dB.
6. Cover Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
7. Electrical Requirements: 115 V, 13 A, 1500 W.

2.4 CUSTODIAL ACCESSORIES

- A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.
- B. Custodial Mop and Broom Holder TA-08:
1. **Basis-of-Design Product:** Subject to compliance with requirements, provide [Bobrick Washroom Equipment, Inc;](#) B-239 or a comparable product by one of the following:
 - a. [AJW Architectural Products.](#)
 - b. [American Specialties Inc.; ASI Group.](#)
 - c. [Bradley Corporation.](#)
 2. Description: Unit with shelf, hooks, and holders.
 3. Length: **34 inches (865 mm)**.
 4. Hooks: Four.
 5. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
 6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
 - a. Shelf: Not less than nominal **0.05-inch- (1.3-mm-)** thick stainless steel.

2.5 MATERIALS

- A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, **0.031-inch- (0.8-mm-)** minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.
- C. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), **0.036-inch- (0.9-mm-)** minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A653/A653M, with **G60 (Z180)** hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.
- G. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).
- H. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.6 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
 - 1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to comply with specified structural-performance requirements.
- C. Shower Seats: Install to comply with specified structural-performance requirements.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 10 2800

SECTION 12 3661.16 - SOLID SURFACING COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid surface material countertops.
 - 2. Solid surface material backsplashes.
 - 3. Solid surface material end splashes.
 - 4. Solid surface material apron fronts.

1.3 ACTION SUBMITTALS

- A. Product Data: For countertop materials.
- B. Shop Drawings: For countertops. Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.
 - 1. Show locations and details of joints.
 - 2. Show direction of directional pattern, if any.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
 - 1. Countertop material, 6 inches (150 mm) square.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

- B. Installer Qualifications: Fabricator of countertops.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of countertops by field measurements before countertop fabrication is complete.

1.7 COORDINATION

- A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

- A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.
 - 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. [Formica Corporation.](#)
 - b. [LG Chemical, Ltd.](#)
 - c. [Samsung Chemical USA, Inc.](#)
 - d. [Swan Corporation \(The\).](#)
 - e. [Wilsonart LLC.](#)
 - 2. Type: Provide Standard type unless Special Purpose type is indicated.
 - 3. Colors and Patterns: As selected by Architect from manufacturer's full range.
- B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 COUNTERTOP FABRICATION

- A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
 - 1. Grade: Premium.
- B. Configuration:
 - 1. Front: Radius edge with apron, **4 inches (100 mm)** high with **3/8-inch (9.5-mm)** radius.
 - 2. Backsplash: Straight, slightly eased at corner.
 - 3. End Splash: Matching backsplash.

- C. Countertops: **1/2-inch- (12.7-mm-)** thick, solid surface material with front edge built up with same material.
- D. Backsplashes: **1/2-inch- (12.7-mm-)** thick, solid surface material.
- E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
 - 1. Fabricate with loose backsplashes for field assembly.
- F. Joints: Fabricate countertops without joints.
- G. Cutouts and Holes:
 - 1. Undercounter Plumbing Fixtures: Make cutouts for fixtures in shop using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.
 - a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting **3/16 inch (5 mm)** into fixture opening.
 - 2. Fittings: Drill countertops in shop for plumbing fittings, undercounter soap dispensers, and similar items.

2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install countertops level to a tolerance of **1/8 inch in 8 feet (3 mm in 2.4 m)**, **1/4 inch (6 mm)** maximum. Do not exceed **1/64-inch (0.4-mm)** difference between planes of adjacent units.
- B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

- C. Fasten subtops to cabinets by screwing through subtops into cornerblocks of base cabinets. Shim as needed to align subtops in a level plane.
- D. Secure countertops to subtops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
- E. Bond joints with adhesive and draw tight as countertops are set. Mask areas of countertops adjacent to joints to prevent adhesive smears.
 - 1. Install metal splines in kerfs in countertop edges at joints. Fill kerfs with adhesive before inserting splines and remove excess immediately after adjoining units are drawn into position.
 - 2. Clamp units to temporary bracing, supports, or each other to ensure that countertops are properly aligned and joints are of specified width.
- F. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.
- G. Install aprons to backing and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears. Fasten by screwing through backing. Pre-drill holes for screws as recommended by manufacturer.
- H. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.
 - 1. Seal edges of cutouts in particleboard subtops by saturating with varnish.
- I. Apply sealant to gaps at walls; comply with Section 07 9200 "Joint Sealants."

END OF SECTION 12 3661.16

SECTION 22 0100 - PLUMBING OPERATING AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Compilation product data and related information appropriate for Owner's operation and maintenance of products furnished under Contract. Prepare operating and maintenance data as specified.
- B. Instruct Owner's personnel in operation and maintenance of equipment and systems.
- C. Submit three copies of complete manual in final form.

1.2 SUBMITTALS

- A. Thirty (30) days after the Contractor has received the final scheduled identified submittals bearing the Architect/Engineer's stamp of acceptance (including resubmittals), submit for review one copy of the first draft of the Operating and Maintenance Manual. This copy shall contain as a minimum:
 - 1. Table of Contents for each element.
 - 2. Contractor information.
 - 3. All submittals, coordination drawings and product data, reviewed by the Architect / Engineer; bearing the Architect / Engineer's stamp of acceptance. (When submittals are returned from Engineer "Correct as Noted", corrected inserts shall be included.)
 - 4. All parts and maintenance manuals for items of equipment.
 - 5. Warranties (without starting dates)
 - 6. Certifications that have been completed. Submit forms and outlines of certifications that have not been completed.
 - 7. Operating and maintenance procedures.
 - 8. Form of Owner's Training Program Syllabus (including times and dates).
 - 9. Control operations/equipment wiring diagrams.
 - 10. Other required operating and maintenance information that are complete.
- B. Copy will be returned to the Contractor within 15 days with comments for corrections.
- C. Submit three (3) completed manuals in final form to the Architect / Engineer one day after substantial completion, and prior to Owner's instructions. Include all specified data, test and balance reports, drawings, dated warranties, certificates, reports, along with other materials and information.
- D. The Architect/Engineer will review the manuals for completeness within fifteen (15) days.
- E. The Contractor shall be notified of any missing or omitted materials. The Manuals shall be reworked by the Contractor, as required, in the office of the Architect / Engineer. The manuals will not be retransmitted.
- F. Two (2) complete Manuals will be delivered to the Owner.

PART 2 - PRODUCTS

2.1 BINDERS

- A. Commercial quality black three-ring binders with clear overlay plastic covers.

- B. Minimum ring size: 1 inch; Maximum ring size: 3 inches.
- C. When multiple binders are used, correlate the data into related groupings.
- D. Label contents on spine and face of binder with full size insert. Label under plastic cover.

PART 3 - EXECUTION

3.1 OPERATION AND MAINTENANCE MANUAL

- A. Form for Manuals:
 - 1. Prepare data in form of an instructional manual for use by Owner's personnel.
 - 2. Format:
 - a. Size: 8-1/2 inch x 11 inch.
 - b. Text: Manufacturer's printed data or neatly typewritten.
 - 3. Drawings:
 - a. Provide reinforced punched binder tab and bind in text.
 - b. Fold larger drawings to size of text pages.
 - 4. Provide flyleaf indexed tabs for each separate product or each piece of operating equipment.
 - 5. Cover: Identify each volume with typed or printed title "Operating and Maintenance Instructions". List:
 - a. Title of Project
 - b. Identity of separate structures as applicable.
 - c. Identity of general subject matter covered in the manual.
 - 6. Binder as specified.
- B. Content of Manual:
 - 1. Neatly typewritten Table of Contents for each volume arranged in systematic order as outlined in the specifications.
 - a. Contractor, name of responsible principal, address and telephone number.
 - b. A list of each product required to be included, indexed to content of the volume.
 - c. List with each product, name, address and telephone number of:
 - 1) Subcontractor or installer.
 - 2) Maintenance contractor as appropriate.
 - 3) Identify area of responsibility of each.
 - 4) Local source of supply for parts and replacement.
 - d. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
 - 2. Product Data:
 - a. Include those sheets pertinent to the specific product.
 - b. Annotate each sheet to:
 - 1) Identify specific product or part installed.
 - 2) Identify data applicable to installation.
 - 3) Delete references to inapplicable information. (All options not supplied with equipment shall be marked out indicated in some manner.
 - 3. Drawings:
 - a. Supplement product data with drawings as necessary to illustrate:
 - 1) Relations of component parts of equipment and systems.
 - 2) Control and flow diagrams.
 - b. Coordinate drawings with information in Project Record Documents to

- assure correct illustration of completed installation.
 - c. Do not use Project Record Documents as maintenance drawings.
 - 4. Written text, as required to supplement product data for the particular installation:
 - a. Organize in consistent format under separate headings for different procedures.
 - b. Provide logical sequence of instructions for each procedure.
 - 5. Copy of each warranty, bond and service contract issued.
 - a. Provide information sheet for Owner's personnel, giving:
 - 1) Proper procedures in event of failure.
 - 2) Instances that might affect validity of warranties or bonds.
 - 6. Shop drawings, coordination drawings and product data as specified.
- C. Sections for Equipment and Systems.
 - 1. Content for each unit of equipment and system as appropriate:
 - a. Description of unit and component parts.
 - 1) Function, normal operating characteristics, and limiting conditions.
 - 2) Performance curves, engineering data and tests.
 - 3) Complete nomenclature and commercial number of replaceable parts.
 - b. Operating procedures:
 - 1) Start up, break-in, routine and normal operating instructions.
 - 2) Regulation, control, stopping, shut down and emergency instructions.
 - 3) Summer and winter operating instructions.
 - 4) Special operating instructions.
 - c. Maintenance procedures:
 - 1) Routine operations
 - 2) Guide to trouble-shooting.
 - 3) Disassembly, repair and reassembly.
 - 4) Alignment, adjusting and checking.
 - 5) Routine service based on operating hours.
 - d. Servicing and lubrication schedule. List of lubricants required.
 - e. Manufacturer's printed operating and maintenance instructions.
 - f. Description of sequence of operation by control manufacturer.
 - g. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
 - 1) Predicted life of part subject to wear.
 - 2) Items recommended to be stocked as spare parts.
 - h. As installed control diagrams by controls manufacturer.
 - i. Complete equipment internal wiring diagrams.
 - j. Each Contractor's coordination drawings.
 - k. As installed color coded piping diagrams.
 - l. Charts of valve tag number, with location and function of each valve.
 - m. List of original manufacturer's spare parts and recommended quantities to be maintained in storage.
 - n. Other data as required under pertinent sections of the specifications.
 - 2. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
 - 3. Additional requirements for operating and maintenance data as outlined in respective sections of specifications.
 - 4. Provide complete information for products specified in Division 22.
 - 5. Provide certificates of compliance as specified in each related section.
 - 6. Provide start up reports as specified in each related section.
 - 7. Provide signed receipts for spare parts and material.

Lake Tawakoni Tournament Facility - Restroom, Hardscape,
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VAN ZANDT COUNTY, TEXAS
STUDIO RED PROJECT NO. 2002

ISSUE FOR BID
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8. Provide training report and certificates.
9. Provide backflow preventer certified test reports.
10. Provide gas piping pressure test reports.

END OF SECTION 22 0100

SECTION 22 0500 - PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Except as modified in this Section, General Conditions, Supplementary Conditions, applicable provisions of the General Requirements, and other provisions and requirements of the contract documents apply to work of Division 22 Plumbing.
- B. Applicable provisions of this section apply to all sections of Division 22, Plumbing.

1.2 CODE REQUIREMENTS AND FEES

- A. Perform work in accordance with applicable statutes, ordinances, codes and regulations of governmental authorities having jurisdiction.
- B. Plumbing work shall comply with applicable inspection services:
 - 1. Underwriters Laboratories
 - 2. National Fire Protection Association
 - 3. State Health Department
 - 4. Local Municipal Building Inspection Department
 - 5. Texas Department of Licensing & Regulations (TDLR)
 - 6. Texas Accessibility Standards (TAS Based on ADA)
- C. Resolve any code violations discovered in contract documents with the Engineer prior to award of the contract. After Contract award, any correction or additions necessary for compliance with applicable codes shall be made at no additional cost to the Owner.
- D. This Contractor shall be responsible for being aware of and complying with asbestos NESHAP regulations, as well as all other applicable codes, laws and regulations.
- E. Obtain all permits required.

1.3 CONTRACTOR'S QUALIFICATIONS

- A. An approved contractor for the work under this division shall be:
 - 1. A licensed specialist in this field and have the personnel, experience, training, skill, and organization to provide a practical working system
 - 2. Able to furnish evidence of having contracted for and installed not less than three systems of comparable size and type that has served their Owners satisfactorily for not less than three years.

1.4 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Requirements in reference specifications and standards are minimum for all equipment, material, and work. In instances where specified capacities, size, or other features of equipment, devices, or materials exceed these minimums, meet specified capacities.

1.5 CONTRACT DRAWINGS

- A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements.

1.6 PROJECT RECORD DOCUMENTS

- A. Maintain at the job site a separate set of white prints (blue line or black line) of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings. Mark the drawings with a colored pencil. Prepare, as the work progresses and upon completion of work, reproducible drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed. Include flow-line elevation of sewer lines. Record existing and new underground and under slab piping with dimensioned locations and elevations of such piping.
- B. At the conclusion of project, obtain without cost to the Owner, erasable mylars of the original drawings and transfer as-built changes to these. Prior to transmittal of corrected drawings, obtain three sets of blue-line prints of each drawing, regardless of whether corrections were necessary and include in the transmittal (two sets are for the Owner's use and one set is for the Architect / Engineer's records). Delivery of these as-built prints and reproducibles is a condition of final acceptance. Provide record drawings on one set each (reproducible Dayrex mylar film positives) and AutoCad 2012 / Revit CAD files on disk (CD Rom).
- C. As-Built drawings should indicate the following information as a minimum:
 1. Indicate all addendum changes to documents.
 2. Remove Engineer's seal, name, address and logo from drawings.
 3. Mark documents RECORD DRAWINGS.
 4. Clearly indicate: DOCUMENT PRODUCED BY
 5. Indicate all changes to construction during construction. Indicate actual routing of all piping, ductwork, etc. that were deviated from construction drawings.
 6. Indicate exact location of all underground plumbing and flow line elevation.
 7. Indicate exact location of all underground plumbing piping and elevation.
 8. Indicate exact location of all underground electrical raceways and elevations.
 9. Correct schedules to reflect (actual) equipment furnished and manufacturer.
 10. During the execution of work, maintain a complete set of drawings and specifications upon which all locations of equipment, ductwork, piping, devices, and all deviations and changes from the construction documents in the work shall be recorded.
 11. Location and size of all ductwork and mechanical piping above ceiling including exact location of isolation of domestic and plumbing valves.
 12. Exact location of all electrical equipment in and outside of the building.
 13. Fire Protection System documents revised to indicate exact location of all sprinkler heads and zone valves.
 14. Exact location of all roof mounted equipment, wall, roof and floor penetrations.
 15. Cloud all changes.

1.7 SPACE REQUIREMENTS

- A. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material that is not suitable in this respect.

1.8 RELATION WITH OTHER TRADES

- A. Carefully study all matters and conditions concerning the project. Submit notification of

conflict in ample time to prevent unwarranted changes in any work. Review other Divisions of these specifications to determine their requirements.

- B. Because of the complicated relationship of this work to the total project, conscientiously study the relation and cooperate as necessary to accomplish the full intent of the documents.
- C. Provide sleeves and inserts in forms as required for the work. Stub up and protect open ends of pipe before any concrete is placed. Furnish sizes of required equipment pads. Furnish and locate bolts and fittings required to be cast in them.
- D. Locate and size openings required for installation of work specified in this Division in sufficient time to prevent delay in the work.
- E. Refer to other Divisions of the specifications for the scope of required connections to equipment furnished under that Division. Determine from the Contractor for the various trades, the Owner, and by direction from the Architect / Engineer, the exact location of all items.

1.9 CONCEALED AND EXPOSED WORK

- A. When the word "concealed" is used in connection with insulating, painting, piping, ducts and the like, the work is understood to mean hidden from sight as in chases, furred spaces or above ceilings. "Exposed" is understood to mean open to view.

1.10 GUARANTEE

- A. Guarantee work for one year from the date of substantial completion of the project. During that period make good any faults or imperfections that may arise due to defects or omissions in material, equipment or workmanship. At the Owner's option, replacement of failed parts or equipment shall be provided.

1.11 MATERIAL AND EQUIPMENT

- A. Furnish new and unused materials and equipment meeting the requirements of the paragraph specifying acceptable manufacturers. Where two or more units of the same type or class of equipment are required, provide units of a single manufacturer.

1.12 NOISE AND VIBRATION

- A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions at no additional cost. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate at no additional cost that equipment performs within designated limits on a vibration chart.

1.13 ACCEPTABLE MANUFACTURERS

- A. Manufacturers names and catalog number specified under sections of Division 22 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified, manufactured by a named manufacturer will be acceptable on approval. A request for prior approval of equipment not listed must be submitted ten (10) days before bid due date. Submit complete design and performance data to the Engineer.

1.14 OPERATING TESTS

- A. After all plumbing systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequencing and operation throughout the range of operation. Tests shall be made in the presence of the Architect / Engineer. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual sections. Submit three copies of all certifications and test reports adequately in advance of completion of the work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.

1.15 WARRANTIES

- A. Submit three copies of all warranties and guarantees for systems, equipment, devices and materials. These shall be included in the Operating and Maintenance Manuals.

1.16 BUILDING CONSTRUCTION

- A. It shall be the responsibility of each sub-contractor to consult the Architectural and Engineering drawings, details, and specifications and thoroughly familiarize himself with the project and all job related requirements. Each subcontractor shall cooperate with the General Contractor to verify that all piping and other items are placed in the walls, furred spaces, chases, etc., so there will be no delays in the job.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 OPENINGS

- A. Framed, cast or masonry openings for ductwork, equipment or piping are specified under other divisions. Drawings and layout work for exact size and location of all openings are included under this division.

3.2 HOUSEKEEPING PADS

- A. Provide equipment housekeeping pads under all floor mounted and ground mounted plumbing equipment, and as shown on the drawings.
- B. Concrete work as specified in Division 3.
- C. Concrete pads:
 - 1. 4 inch high, rounded edges, minimum 2500 psi unless otherwise indicated on the drawings
 - 2. Chamfer strips at edges and corner of forms.
 - 3. Smooth steel trowel finish.
 - 4. Doweled to existing slab
- D. Install concrete curbs around multiple pipe penetrations.

3.3 VANDAL RESISTANT DEVICES

- A. Provide a handle for each loose keyed operated valve and hose bibb on the project.

- B. Where vandal resistant screws or bolts are employed on the project, deliver to the Owner two suitable tools for use with each type of fastener used.
- C. Proof of delivery of these items to the Owner shall be included in the Operating and Maintenance Manuals.

3.4 INSTRUCTION OF OWNER'S PERSONNEL

- A. Prior to final inspection, conduct an on-site training program to instruct the Owner's operating personnel in the operation and maintenance of the plumbing systems.
 - 1. Provide the training during the Owner's regular working day.
 - 2. The Instructors shall each be experienced in their phase of operation and maintenance of building plumbing systems and with the project.
- B. Time to be allocated for instructions.
 - 1. Minimum of 8 hours dedicated instructor time.
 - 2. 4 hours on each of 2 days.
- C. Before proceeding with the on-site training program, submit the program syllabus; proposed time and dates; and other pertinent information for review and approval.
 - 1. One copy to the Owner.
 - 2. One copy to the Architect / Engineer.
- D. The Owner will provide a list of personnel to receive instructions, and will coordinate their attendance at the agreed upon times.
- E. Use the operation and maintenance manuals as the basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut down of each item of equipment.
- G. Demonstrate equipment functions (both individually and as part of the total integrated system).
- H. Prepare and insert additional data in the operating and maintenance manuals when the need for additional data becomes apparent during instructions.
- I. Submit a report within one week after completion of the training program that instructions have been satisfactorily completed. Give time and date of each demonstration and hours devoted to the demonstration, with a list of people present.
- J. At the conclusion of the on-site training program, have the person designated by the Owner sign a certificate to certify that he/she has a proper understanding of the system, that the demonstrations and instructions have been satisfactorily completed, and the scope and content of the operating and maintenance manuals used for the training program are satisfactory.
- K. Provide a copy of the report and the certificate in an appropriately tabbed section of each Operating and Maintenance Manual.

3.5 EQUIPMENT IDENTIFICATION

- A. Provide a laminated engraved plastic nameplate on each piece of equipment and starter.

1. Designation approved by Architect / Engineer.
2. Equipment includes, but is not limited to, water heaters, pumps, boilers and utility controllers.
3. Submit schedule of equipment to be included and designations.

B. Provide nameplates with ½ inch high letters and fastened with epoxy or screws.

3.6 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
1. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided.
 2. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- B. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

3.7 PROTECTION

- A. Protect work, equipment, fixtures, and materials. At work completion, work must be clean and in original manufacturer's condition.

END OF SECTION 22 0500

SECTION 22 0510 - PLUMBING CONTRACT QUALITY CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Contract quality control including workmanship, manufacturer's instructions and demonstrations.

1.2 QUALITY CONTROL PROGRAM

- A. Maintain quality control over supervision, subcontractors, suppliers, manufacturers, products, services, site conditions and workmanship to produce work in accordance with contract documents.

1.3 WORKMANSHIP

- A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
- B. Perform work by persons qualified to produce workmanship of specified quality.
- C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking. Under no conditions shall material or equipment be suspended from structural bridging.
- D. Provide finishes to match approved samples. All exposed finishes shall be approved by the Architect. Submit color samples as required.

1.4 MANUFACTURER'S INSTRUCTIONS

- A. Comply with instructions in full detail, including each step in sequence.
- B. Should instruction conflict with Contract Documents, request clarification from Architect / Engineer before proceeding.

1.5 MANUFACTURER'S CERTIFICATES

- A. When required in individual Specification Sections, submit manufacturer's certificate in duplicate, certifying that products meet or exceed specified requirements.

1.6 MANUFACTURER'S FIELD SERVICES

- A. When required in individual Specification Sections, manufacturer shall provide qualified personnel to observe:
 1. Field conditions.
 2. Condition of installation.
 3. Quality of workmanship.
 4. Start-up of equipment.
 5. Testing, adjusting, and balancing of equipment.
- B. Representative shall make written report of observations and recommendations to Architect / Engineer.

PART 2 - PRODUCTS

SALAS O'BRIEN

PLUMBING CONTRACT QUALITY CONTROL

22 0510-1

Salas O'Brien Registration #F-4111

2.1 REFERENCE APPLICABLE SPECIFICATION SECTIONS

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT

- A. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the Contractor is obligated to furnish new equipment of a like kind at no additional cost to the Owner.

- B. Adequately protect equipment from damage after delivery to the project. Cover with heavy tarpaulins, drop cloths or other protective coverings as required to protect from plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion.

END OF SECTION 22 0510

SECTION 22 0512 - PLUMBING SHOP DRAWINGS, COORDINATION DRAWINGS & PRODUCT DATA

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Prepare submittals as required by Division 1.
- B. The term submittal, as used herein, refers to all:
 - 1. Shop Drawings
 - 2. Coordination Drawings
 - 3. Product data
- C. Submittals shall be prepared and produced for:
 - 1. Distribution as specified
 - 2. Inclusion in the Operating and Maintenance Manual, as specified, in the related section

1.2 SHOP DRAWINGS

- A. Present drawings in a clear and thorough manner. Identify details by reference to sheet and detail, schedule, or room numbers shown on Contract Drawings.
- B. Show all dimensions of each item of equipment on a single composite Shop Drawing. Do not submit a series of drawings of components.
- C. Identify field dimensions; show relationship to adjacent features, critical features, work, or products.
- D. Submit shop drawings in plan, elevation and sections, showing equipment in mechanical equipment areas.

1.3 COORDINATION DRAWINGS

- A. Present in a clear and thorough manner. Title each drawing with project name. Identify each element of drawings by reference to sheet number and detail, or room number of contract documents. Minimum drawing scale: ¼ inch = 1 foot - 0 inch.
- B. Prepare coordination drawings to coordinate installations for efficient use of available space, for proper sequence of installation, and to resolve conflicts. Coordinate with work specified in other sections and other divisions of the specifications.
- C. For each mechanical room and for each outside equipment pad where equipment is located, submit plan and elevation drawings. Show:
 - 1. Actual mechanical equipment and components to be furnished
 - 2. Service clearance
 - 3. Relationship to other equipment and components
 - 4. Roof drains and leader piping
 - 5. Fire protection piping and equipment
- D. Identify field dimensions. Show relation to adjacent or critical features of work or products.
- E. Related requirements:
 - 1. Ductwork shop drawings
 - 2. Coordination drawing specified in Division 26

- F. Submit shop drawings in plan, elevation and sections, showing equipment in mechanical equipment areas.
- G. Gas piping sketch indicating proposed location of piping prior to proceeding with the installation.

1.4 PRODUCT DATA AND INSTALLATION INSTRUCTION

- A. Submit only pages which are pertinent to the project. All options which are indicated on the product data shall become part of the contract and shall be required whether specified are not.
- B. Mark each copy of standard printed data to identify pertinent products, referenced to specification section and article number.
- C. Show reference standards, performance characteristics and capacities; wiring and piping diagrams and controls; component parts; finishes; dimensions and required clearances.
- D. Modify manufacturer's standard schematic drawings and diagrams to supplement standard information and to provide information specifically applicable to the work. Delete information not applicable.
- E. Mark up a copy of the specifications for the product. Indicate in the margin of each paragraph the following: "Comply, "Do Not Comply", or "Not Applicable". Explain all "Do Not Comply" statements.
- F. Provide a separate transmittal for each submittal item. Transmittals shall indicate product by specification section name and number. Separate all submittals into appropriate specification section number. Do not combine specification sections.

1.5 MANUFACTURERS INSTRUCTIONS

- A. Submit Manufacturer's instructions for storage, preparation, assembly, installation, start-up, adjusting, calibrating, balancing and finishing.

1.6 CONTRACTOR RESPONSIBILITIES

- A. Review submittals prior to transmittal.
- B. Determine and verify:
 - 1. Field measurements
 - 2. Field construction criteria
 - 3. Manufacturer's catalog numbers
 - 4. Conformance with requirements of Contract Documents
- C. Coordinate submittals with requirements of the work and of the Contract Documents.
- D. Notify the Architect/Engineer in writing at time of submission of any deviations in the submittals from requirements of the Contract Documents.
- E. Do not fabricate products, or begin work for which submittals are specified, until such submittals have been produced and bear contractor's stamp. Do not fabricate products or begin work scheduled to have submittals reviewed until return of reviewed submittals with Architect/Engineer's acceptance.

- F. Contractor's responsibility for errors and omissions in submittals is not relieved whether Architect/Engineer reviews submittals or not.
- G. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved whether Architect/Engineer reviews submittals or not, unless Architect/engineer gives written acceptance of the specific deviations on reviewed documents.
- H. Submittals shall show sufficient data to indicate complete compliance with Contract Documents:
 - 1. Proper sizes and capacities
 - 2. That the item will fit in the available space in a manner that will allow proper service
 - 3. Construction methods, materials and finishes
- I. Schedule submissions at least 15 days before date reviewed submittals will be needed.

1.7 SUBMISSION REQUIREMENTS

- A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Project or in the work of any other Contractor.
- B. Number of submittals required:
 - 1. Shop Drawings and Coordination Drawings: Submit one reproducible transparency and three opaque reproductions.
 - 2. Product Data: Submit the number of copies which the contractor requires, plus those which will be retained by the Architect/Engineer.
- C. Accompany submittals with transmittal letter, in duplicate, containing:
 - 1. Date
 - 2. Project title and number
 - 3. Contractor's name and address
 - 4. The number of each Shop Drawing, Project Datum and Sample submitted
 - 5. Other pertinent data
- D. Submittals shall include:
 - 1. The date of submission
 - 2. The project title and number
 - 3. Contract Identification
 - 4. The names of:
 - a. Contractor
 - b. Subcontractor
 - c. Supplier
 - d. Manufacturer
 - 5. Identification of the product
 - 6. Field dimensions, clearly identified as such
 - 7. Relation to adjacent or critical features of the work or materials
 - 8. Applicable standards, such as ASTM or federal specifications numbers
 - 9. Identification of deviations from contract documents
 - 10. Suitable blank space for General Contractor and Architect/Engineer stamps
 - 11. Contractor's signed and dated Stamp of Approval
- E. Coordinate submittals into logical groupings to facilitate interrelation of the several items:
 - 1. Finishes which involve Architect/Engineer selection of colors, textures or patterns

2. Associated items which require correlation for efficient function or for installation

1.8 SUBMITTAL SPECIFICATION INFORMATION

- A. Every submittal document shall bear the following information as used in the project manual:
 1. The related specification section number
 2. The exact specification section title
- B. Submittals delivered to the Architect/Engineer without the specified information will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

1.9 RESUBMISSION REQUIREMENTS

- A. Make re-submittals under procedures specified for initial submittals.
 1. Indicate that the document or sample is a re-submittal
 2. Identify changes made since previous submittals
- B. Indicate any changes which have been made, other than those requested by the Architect / Engineer.

1.10 CONTRACTOR'S STAMP OF APPROVAL

- A. Contractor shall stamp and sign each document certifying to the review of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.
- B. Contractor's stamp of approval on any submittal shall constitute a representation to Owner and Architect/Engineer that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that Contractor has reviewed or coordinated each submittal with the requirements of the work and the Contract Documents.
- C. Do not deliver any submittals to the Architect/Engineer that do not bear the Contractor's stamp of approval and signature.
- D. Submittals delivered to the Architect/Engineer without Contractor's stamp of approval and signature will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

1.11 ARCHITECT/ENGINEER REVIEW OF IDENTIFIED SUBMITTALS

- A. The Architect/Engineer will:
 1. Review identified submittals with reasonable promptness and in accordance with schedule
 2. Affix stamp and initials or signature, and indicate requirements for re-submittal or approval of submittal
 3. Return submittals to Contractor for distribution or for resubmission
- B. Review and approval of submittals will not extend to design data reflected in submittals which is peculiarly within the special expertise of the Contractor or any party dealing directly with the Contractor.

- C. Architect/Engineer's review and approval is only for conformance with the design concept of the project and for compliance with the information given in the contract.
 - 1. The review shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto.
 - 2. The review shall not extend to review of quantities, dimensions, weights or gauges, fabrication processes or coordination with the work of other trades.
- D. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

1.12 SUBSTITUTIONS

- A. Do not make requests for substitution employing the procedures of this Section.
- B. The procedure for making a formal request for substitution is specified in Div. 1.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION 22 0512

SECTION 22 0513 - ELECTRICAL PROVISIONS OF PLUMBING WORK

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electrical provisions to be provided as plumbing work are indicated in other Division 22 sections, on drawings, and as specified.
- B. Types of work, normally recognized as electrical but provided as plumbing, specified or partially specified in this Section, include but are not necessarily limited to the following:
 - 1. Motors for plumbing equipment.
 - 2. Starters for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 3. Wiring from motors to disconnect switches or junction boxes for motors of plumbing equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 4. Wiring of field-mounted float control switches, flow control switches, and similar plumbing-electrical devices provided for plumbing systems, to equipment control panels.
 - 5. Pipe heat tracing.
- C. Refer to Division 22 sections for specific individual plumbing equipment electrical requirements.
- F. Refer to Division 26 sections for motor starters and controls not furnished integrally with plumbing equipment.
- G. Refer to Division 26 sections for junction boxes and disconnect switches required for motors and other electrical units of plumbing equipment.

1.2 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Sections, apply to work of this Section.

1.3 QUALITY ASSURANCE

- A. Wherever possible, match elements of electrical provisions of plumbing work with similar elements of electrical work specified in Division 26 sections for electrical work not otherwise specified.
- B. For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards for definitions of terminology. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements.

1.4 SUBMITTALS

- A. Include in listing of motors, voltage, notation of whether motor starter is furnished or installed integrally with motor or equipment containing motors.

PART 2 - PRODUCTS

2.1 MOTORS

SALAS O'BRIEN

ELECTRICAL PROVISIONS OF PLUMBING WORK

22 0513-1

Salas O'Brien Registration #F-4111

- A. Provide motors for plumbing equipment manufactured by one of the following:
 - 1. Baldor Electric Company.
 - 2. Century Electric Div., Inc.
 - 3. General Electric Co.
 - 4. Louis Allis Div.; Litton Industrial Products, Inc.
 - 5. Lincoln Electric
 - 6. Marathon Electric Mfg. Corp.
 - 7. Reliance Electric Co.
 - 8. Westinghouse Electric Corp.

- B. Motor Characteristics. Except where more stringent requirements are indicated, and except where required items of plumbing equipment cannot be obtained with fully complying motors, comply with the following requirements for motors of plumbing work:

- C. Temperature Rating. Rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).

- D. Provide each motor capable of making starts as frequently as indicated by automatic control system, and not less than 5 starts per hour for manually controlled motors.

- E. Phases and Current Characteristics. Provide squirrel-cage induction polyphase motors for $\frac{3}{4}$ hp and larger, and provide capacitor-start single-phase motors for $\frac{1}{2}$ hp and smaller, except $\frac{1}{6}$ hp and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 sections, and with individual equipment requirements specified in other Division 22 requirements. For 2-speed motors provide two separate windings on polyphase motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.

- F. Service Factor. 1.15 for polyphase motors and 1.35 for single-phase motors.

- G. Motor Construction. Provide general purpose, continuous duty motors, Design "B" except "C" where required for high starting torque.
 - 1. Frames. NEMA #56.
 - 2. Bearings are to be ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual section of Division 22 for fractional-hp light-duty motors where sleeve-type bearings are permitted.
 - 3. Except as indicated, provide open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division 22 for other enclosure requirements.
 - 4. Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
 - 5. Noise Rating: Provide "Quiet" rating on motors.

- H. All motors shall be premium efficiency.

2.2 EQUIPMENT FABRICATION

- A. Fabricate plumbing equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives. Arrange for lubrication and similar running-maintenance without removal of guards.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, anchored to resist torque, drive thrusts, and other external forces inherent in plumbing work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.
- B. Verify voltage with Electrical Plans.

END OF SECTION 22 0513

SECTION 22 0515 - PLUMBING EARTHWORK

PART 1 - GENERAL

- A. Excavate and backfill for pipe trenches for underground piping, and excavate for structures installed as part of plumbing work.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Excavate trenches for underground piping to the required depth to ensure 2 foot minimum coverage over piping.
- B. Cut the bottom of the trench or excavation to uniform grade.
- C. Should rock be encountered, excavate 6 inches below grade, fill with bedding material and tamp well.
- D. Lay out alignment of pipe trenches to avoid obstructions. Assure that proposed route of pipe will not interfere with building foundation before any cutting is begun. Should interference be found, contact the Architect/Engineer before proceeding.

3.2 BACKFILL

- A. Backfill shall not be placed until the work has been inspected, tested and approved. Complete backfill to the surface of natural ground or to the lines and grades shown on drawings. Except where special materials are requested, use suitable friable soils from other excavation as backfill material. Do not use peat, silt, muck, debris or other organic materials. Deposit backfill in uniform layers and compact each layer as specified in Division 2.
- B. Compacting Backfill. Place material in uniform layers of prescribed maximum thickness and wet or dry the material to optimum moisture content. Compact with power-driven tampers to the prescribed density. Place regular backfill in 8 inch maximum layers, loose measure. Compact to not less than 95 percent of maximum soil density as determined by ASTM D-698 Standard Proctor.
- C. Restoration. Compact backfill, where trenching or excavation is required in improved areas such as pavements, walks, and similar areas, to a condition equal to the adjacent undisturbed earth, and restore surface of the area to the condition existing prior to trenching or excavating operation.
- D. Provide 6 inch stabilized sand bed with 4 inch stabilized sand cover around each pipe.

3.3 DISPOSAL OF EXCESS MATERIAL

- A. Remove excess excavation material or material unsuitable for backfill. Excess material can be spread on grade, or shall be removed from site as directed by the Owner/Architect.

END OF SECTION 22 0515

SECTION 22 0516 - EXCAVATING, BACKFILLING AND COMPACTING FOR UTILITIES OUTSIDE
BUILDING SLAB

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 apply to this section.
- B. Refer to Instructions to Bidders for substitution of materials and products.
- C. Addenda issued during the bidding period that affect this section of the specifications.

1.2 WORK INCLUDED

- A. Coordinating all excavating and backfilling for the underground storm sewer, sanitary sewer, water distribution lines, and all related appurtenances.
- B. The extent of lines, excavation, and backfill shall be in conformance with the locations, lines, elevations and grades shown on the drawings prepared by the MEP Engineer.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Earthwork
- B. Water Distribution
- C. Sanitary Sewer
- D. Plumbing

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM) Use current edition.
 - 1. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)
 - 2. ASTM D1556, Standard Test method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
 - 3. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
 - 4. ASTM D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- B. City Standards
- C. Local Governing Agencies
- D. Texas Health and Safety Code, Chapter 161, Subchapter Q, as amended by House Bill No. 1927.

1.5 WARRANTY

- A. Provide written warranty against defects in the material and workmanship for the work of this Section for a period of one year from the Date of Substantial Completion of the Project. Refer to Division 1 for Warranty form.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Cement-Stabilized Sand: Clean, local sand mixed with not less than 1-1/2 sacks of Portland cement per ton; mix in a mill-type mixer.
- B. Sand: Clean, local sand
- C. Earth Backfill: Clean local material consistent with the surrounding earth material and free of large clods, roots, rocks or other debris.

PART 3 – EXECUTION

3.1 EXCAVATION

- A. General:
 - 1. All utility trenches shall be constructed in conformance with OSHA trench safety standards.
 - 2. Sheet piling and shoring shall be accomplished to the extent necessary to maintain the sides of the trench in a vertical position throughout the construction period for trenches five feet in depth or deeper. Where approved, trench sides may be laid back in lieu of shoring to meet OSHA safety standards.
 - 3. Utilities shall not be constructed or laid in a trench in the presence of water. All water shall be sufficiently removed from the trench prior to the line placing operation to ensure a dry, firm bed on which to place the utility line.
- B. Storm and Sanitary Sewer Trenches:
 - 1. For pipe sizes less than 42 inches in diameter, the minimum trench width shall be outside diameter of pipe plus 18 inches.
 - 2. Trenches shall be excavated to a depth of at least 6 inches below the barrel of pipe.
- C. Appurtenances:
 - 1. Any overdepth excavation below appurtenances shall be refilled with cement-stabilized sand.
- D. Water Line Trenches:
 - 1. Water lines shall be at least two feet in depth from the top of proposed grade to the top of pipe.
 - 2. Trench width for water lines shall be a minimum of the outside pipe diameter plus 18 inches.
 - 3. Trenches shall be excavated to a depth of at least 6 inches below the barrel of pipe.

3.2 PIPE BEDDING AND BACKFILL

- A. Storm and Sanitary Sewer Trenches:

1. The cement-stabilized sand bedding shall not extend from a point 6 inches below the bottom of the pipe to the level of the spring line. This material shall not be used after it loses its moisture content.
 2. The cement-stabilized sand shall be thoroughly rodded after being placed in the trench.
 3. Bedding, sewer pipe, and initial backfill over the pipe must be placed in a single day for any given portion of pipe. Initial backfill shall be placed to one foot above the top of pipe for earth backfill and 6 inches over the top of pipe for cement-stabilized sand backfill.
 4. Remainder of trench backfill shall be placed the next day or later in 8 inch lifts.
 5. Backfill shall be placed in uniform layers not to exceed 8 inches loose depth, and compacted to a minimum of 95 percent of Standard Maximum Density (ASTM D698).
 6. Backfill, under pavement and to one foot from outer edge, shall be cement-stabilized sand, up to one foot below subgrade elevation. Remainder of backfill to subgrade to be as specified in paragraph 5 above and stabilized where required.
- B. Water Line Trenches:
1. Pipe bedding shall consist of 6 inches of clean sand placed before the pipe is laid.
 2. After laying pipe and ensuring that the pipe is properly placed and supported by the sand bedding, clean sand backfill shall be placed to 6 inches above the top of pipe. The sand backfill shall be thoroughly rodded and tamped for compaction.
 3. For water lines to be beneath the building and pavement and to one foot from the outer edge of pavement, the remainder of the trench backfill shall be clean sand placed in 6 inch lifts and compacted to 95 percent Standard Proctor.
 4. For water lines not beneath the building and pavement or within one foot from the outer edge of pavement the remainder of the trench backfill shall be earth fill placed in uniform layers not to exceed 8 inch loose depth. Each lift shall be compacted to a minimum of 90 percent of Standard Density (ASTM D698) at the proper moisture content specified in the soils report for this project. All earth backfill shall be placed the next day or later after the pipe is laid.
- C. Natural Gas Trenches:
1. Natural gas lines shall not be installed under slabs on grade unless pipes are sleeved and vented as per Section 22 63 11.
 2. Natural gas lines shall not be installed in trenches with other utilities.
- D. Utility Locators:
1. Provide metallic locator over all underground utilities, including irrigation piping, plumbing, control wiring, conduit, data, etc. Locator tape shall be a maximum of 12 inches below grade and centered over the utility(s).

END OF SECTION 22 0516

SECTION 22 0517 - PLUMBING ACCESS DOORS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install access doors in wall or ceiling locations as required or shown for access to valves, controls, regulating devices, water arresters and other equipment requiring maintenance, adjustment or operation.

PART 2 - PRODUCTS

2.1 NON-FIRE RATED ACCESS DOORS

- A. 16-Gauge frames
- B. 14-gauge steel panels
- C. Continuous fully concealed hinges
- D. Flush screwdriver cam lock & cylinder lock for Owner selection
- E. Prime coat finish
- F. Brushed satin stainless steel finish for restroom, kitchen or cafeteria installation
- G. Material suitable for wall and/or ceiling mounting

2.2 FIRE RATED ACCESS DOORS

- A. UL listed, 1-1/2 hour Label "B", access doors
- B. 16-Gauge stainless steel
- C. 20-Gauge insulated sandwich-type door panel.
- D. Two inch thick with fire rated insulation
- E. Continuous fully concealed hinge
- F. Automatic closing and latching mechanism
- G. Knurled knob and recessed key operation for Owner selection
- H. Interior latch release slide for opening from inside
- I. Prime coat finish
- J. Material suitable for wall and/or ceiling mounting

2.3 ACCEPTABLE MANUFACTURERS

- A. Milcor

- B. MIFAB
- C. Acudor
- D. Elmdor

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Access doors specified in Division 22 will be installed by other crafts. Not all required access doors are shown. Coordinate with the Contractor to locate access doors for ease of operation and maintenance of concealed equipment.
- B. Installation shall be in accordance with the manufacturer's printed instructions.
- C. Minimum size required:
 - 1. 24 inch x 24 inch for plumbing multiple isolation valves and electrical related items in ceilings
 - 2. 8 inch x 8 inch for plumbing for single isolation valve or shock arrestor

END OF SECTION 22 0517

SECTION 22 0519 - PRESSURE AND TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This section specifies gauges, thermometers, wells and/or pressure and temperature test stations to be installed as specified.

1.2 RELATED WORK

- A. Division 22, Plumbing
 - 1. Plumbing General Provisions
 - 2. Pipe and Pipe Fittings, General
 - 3. Valves, Strainers and Vents

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - GAUGES AND THERMOMETERS

- A. Terice
- B. Taylor
- C. Marsh
- D. Weksler
- E. Marshalltown
- F. Weiss
- G. Miljoco

2.2 PRESSURE GAUGES

- A. Case and Ring: 4 inch type 304 stainless steel; liquid filled case with stainless steel bayonet ring.
- B. Dial: White aluminum with black markings
- C. Window: Clear acrylic
- D. Tube: Phosphor bronze and forged brass socket.
- E. Gauge accuracy: +/- 1 percent over operating range.
- F. For pulsating service, provide impulse dampers.
- G. Without flange for pipe mounting.
- H. With flange for wall mounting.
- I. Weiss Model: Domestic Water 4CTS LF (Lead Free) 0-100 PSI

2.3 THERMOMETER WELLS

- A. Brass or type 300 stainless steel. Machined bar stock, 1-piece construction (Lead Free).
- B. Where installed in insulated piping or vessels, provide with extension neck to match insulation thickness.
- C. Provide metal-to-metal contact with bulb chamber for maximum sensitivity.
- D. Wells shall be sized to extend a minimum of 50 percent into pipe.

2.4 THERMOMETERS IN PIPING SYSTEMS OR VESSELS

- A. Die cast aluminum case with baked epoxy finish.
- B. Adjustable angle 9 inch scale length.
- C. Clear acrylic window.
- D. Brass stem, length to match well.
- E. Red reading organic spirit filled-in magnifying glass column.
- F. White background with black figures and markings.
- G. Brass stems and union connections (Lead Free).
- H. Accuracy: +/- 1 percent of scale range.
- I. Range:
 - 1. Hot water lines: 30 deg. F to 240 deg. F.

2.5 PRESSURE AND TEMPERATURE TEST STATIONS

- A. "Test Station" fitting to receive either a temperature or pressure probe. Fitting shall be solid brass with two valve cores of Nordel (Lead Free).
 - 1. Fitted with a color coded cap strap with gasket.
 - 2. Acceptable Manufacturer: Peterson Equipment Company.
 - 3. Provide with extension neck to match insulation thickness.
- B. Provide to the Owner a fitted case with:
 - 1. Two 0-100 psi pressure gauges as specified and adapters with 1/8 inch OD probe.
 - 2. Four 5 inch stem pocket testing thermometers.
 - a. Two with range 0 deg. F to 220 deg. F for hot water.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with drawing details and manufacturer's recommendations.
- B. Provide a ball valve at each gauge (Lead Free).
- C. Locate gauges and thermometers to be easily readable from the floor at a 5 foot-6 inch

eye level. Use adjustable angle or rigid stem as required. Install gauges in upright position.

- D. Install gauges in the following locations: across pumps, storage tanks, heat exchangers.
- E. Install thermometer in the following locations: At storage tanks, across heat exchangers, across boiler, leaving side of water heater, leaving water side of tempered water valves, and hot water supply and return lines.
 - 1. Hot water lines: 30 deg. F to 240 deg. F.
 - 2. Tempered water valves 0 deg. F to 120 deg. F.

END OF SECTION 22 0519

SECTION 22 0523 - VALVES, STRAINERS AND VENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Plumbing Valves
- B. Pipe strainer,

PART 2 - PRODUCTS

2.1 VALVES

- A. Pressure Ratings:
 - 1. Unless otherwise indicated, use valves suitable for 125 minimum psig working steam pressure (WSP) and 450 deg. F.
 - 2. The pressure temperature rating of valves shall be not less than the design criteria applicable to components of the system.
- B. Butterfly Valves
 - 1. Butterfly valves shall conform to MSS-SP67.
 - 2. Liners, inserts and discs shall be suitable for the intended service.
 - 3. Valves shall have a full lug type body designed for installation between ANSI standard flanges, and shall be rated at full working pressure with downstream flange removed.
 - 4. All valves for domestic use must be lead free.
- C. Balancing Valves
 - 1. Provide balancing valves with:
 - a. Corrosion resistant plug with resilient seal when required.
 - b. O-ring stem seal.
 - c. Permanently lubricated, corrosion resistant bearings.
 - 2. Connections
 - a. Through 2 inch pipe size use threaded connections.
 - b. For valves 2-1/2 inch pipe size and larger shall be provided with 150 psig flange connections.
 - 3. Provide each valve with:
 - a. Memory stop.
 - b. Plastic drip cap.
 - c. 1/8 inch gauge tap.
 - 4. All valves for domestic use must be lead free.
- D. Ball Valves
 - 1. Provide ball valves with:
 - a. Blowout proof stem.
 - b. Full size port, 316 stainless steel ball and stem.
 - c. Cast bronze body.
 - d. Threaded ends.
 - 2. Seat, seals, thrust washers and packing shall be suitable for the intended service.
 - 3. Service rating:
 - a. 150 psi saturated steam.
 - b. 600 psi WOG.
 - 4. Provide with memory stop for balancing valves.
 - 5. Where Viega ProPress fittings are used, Viega ProPress ball valves may be

- used.
 - 6. All valves for domestic use must be lead free.
- E. Valve Connections
- 1. Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves. Sweated joints are not allowed.
 - 2. Thread pipe sizes 2 inches and smaller.
 - 3. Flange pipe sizes 2-1/2 inches and larger.
 - 4. Use screw to solder adapters for copper tubing.
 - 5. Use grooved body valves with mechanical grooved jointed piping.
 - 6. Use press valves when using copper press systems.
- F. Valve Operators
- 1. Provide suitable hand-wheels for gate, globe, angle or drain valves and inside hose bibbs.
 - 2. When cocks and valves are furnished with square head stem:
 - a. Provide one wrench for every ten cocks or valves sized 2 inches and smaller, minimum of two.
 - b. Provide each cock or valve size 2-1/2 inches and larger with a wrench with setscrew.
 - 3. Where butterfly valves are provided:
 - a. Provide gear operators on valves 6 inches and larger.
 - b. Where valves are located 7 feet or more above the finished floor in equipment room areas provide chain-operated sheaves. Extend chains to about 5 feet above floor and hook to clips, arrange to clear walking space.
 - c. Lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock and nut and memory stop for throttling service on valves 4 inches and smaller.
- G. Acceptable Manufacturers (All listed must be lead free):
- 1. Apollo
 - 2. Crane
 - 3. Dezurik
 - 4. Jenkins
 - 5. Keystone
 - 6. Kitz
 - 7. Milwaukee Valve
 - 8. Nibco
 - 9. Stockham
- H. Check Valves
- 1. Bronze body, 2 inches and smaller, bronze disc (Teflon disc for steam service), regrinding swing check, screw-in cap, threaded connection (Lead Free).
 - 2. Iron body, 2-1/2 inches and larger, bronze trim, non-slam: stainless steel pins and springs, and bronze plate or bronze mounted, regrind-renew check, bronze seat ring and disc. Provide either wafer or threaded lug (Lead Free).
 - 3. Acceptable Manufacturers (All listed must be lead free):
 - a. Apollo
 - b. Keystone
 - c. Kitz
 - d. Milwaukee
 - e. Mission Duocheck
 - f. Nibco

- I. Backflow Preventer (All valves for domestic use must be lead free):
 - 1. BFP-1 (2 inches and smaller) bronze body, reduced pressure zone type with two inline independent check valves with an intermediate relief valve, complete with two full port ball valve shut-offs and ball type test cocks. Bronze strainer on inlet. Provide air gap fitting with full size drain piped to nearest floor drain. Watts 909-QT-S-LF.
 - 2. BFP-2 (2-1/2 inches and larger) stainless steel or FDA epoxy coated ductile iron reduced pressure zone type with two inline independent check valves with reverse relief valves, two non-rising stem resilient sealed gate valves, cast iron strainer on inlet. Provide air gap fitting piped full size to nearest floor drain. Apollo RP4ALF-YS or Watts 909-NRS-BB-S-LF.
- J. Provide valves of same manufacturer throughout where possible.
- K. Provide valves with manufacturer's name and manufacturing location, duty and pressure rating clearly marked on outside of body.
- L. Where valves are installed in insulated piping, provide with extended neck so valve operator and stop plate clears the full thickness insulation.
- M. Provide valve, seat and trim materials suitable for the intended service.
- N. Provide memory stops for all valves used for throttling service. Valves for throttling service shall be butterfly, plug, globe or ball type.

2.2 PIPE SYSTEMS STRAINERS

- A. Body:
 - 1. Bronze "Y" pattern or basket as shown on the drawings.
 - 2. Line size.
 - 3. Threaded strainer blow down port.
 - 4. ASTM A #126 Class B Cast Iron Body.
- B. Construction:
 - 1. 2 inch size and smaller with screw connections rated 400 psi WOG.
 - 2. Over 2 inch size with flanged connections, rated 125 psi WOG.
- C. Fabricate screens of Monel or type 304 stainless steel:
 - 1. With 20 mesh woven wire in piping systems through 2 inches.
 - 2. With 0.045 perforations in piping systems 2-1/2 inches and 3 inches.
 - 3. With 0.125 perforations in piping systems 4 inches and larger.
- D. Start-up:
 - 1. Provide an additional fine mesh disposable screen for use during start-up operations.
 - 2. Remove after 30 days.
 - 3. Attach to piping for Owner's review.
- E. Acceptable Manufacturers (All listed must be lead free):
 - 1. Apollo
 - 2. Crane
 - 3. Keckley
 - 4. Kitz
 - 5. Mueller

6. McAlear
7. Muesco
8. Nibco
9. Zurn

2.3 VALVE SCHEDULE

A. Domestic Service

1. Gas shut-off service: UL approved for natural gas service.
 - a. Nibco Ball Valve, full port through 1 inch: T-585-70-UL
 - b. Nibco Ball Valve conventional port 1-1/4 inch through 3 inch: T-580-70-UL
 - c. Resun 2-1/2 inch and larger: 143 - 1-UL
 - d. DeZurick 2-1/2 inch and larger: Series 425 or 435
 - e. Locking Type: Rockford 3/4 inch and 1 inch PNP-400
Mueller 1-1/4 inch through 4 inch: Lub-O-seal
 - f. Conbraco Ball Valve, full port through 4 inch: 64-100 Series
 - h. Milwaukee Full Port 1/4 inch-2 inch
 - i. Milwaukee Standard Port 2-1/2 inch & 3 inch
 - j. Kitz Full Port 2 inch -- #68
2. Cold and Hot water service (all listed must be Lead Free):
 - a. Nibco Ball Valve full port through 2 inch: T-585-66-LF
 - b. Nibco Ball Valve 2-1/2 inch and 3 inch conventional port: T-580-66-LF
 - c. Nibco Butterfly Valve 4 inch and larger: LD-2000 EDPM Gaskets
 - d. Watts Ball Valve 4 inch and larger: G-4000-FDA
 - e. Viega ProPress Bronze Ball Valves (where Viega ProPress fittings are used)
 - f. Kitz Full Port through 2 inch - #868M Lead Free
 - h. Milwaukee Full Port 1/4 inch-2 inch
 - i. Milwaukee Standard Port 2-1/2 inch & 3 inch
 - j. Apollo Ball Valve Full Port through 2-1/2 inch 77CALF
 - k. Apollo Ball Valve Standard Port 3 inch 70LF
 - l. Apollo Butterfly Valve 4 inch and Larger LD141
 - m. Apollo Press Bronze Ball valves – 77 WLF
3. Compressed air system
 - a. Nibco Ball Valve full port through 2 inch: T-585-70-66
 - b. Nibco Ball Valve 2-1/2 inch and 3 inch conventional port: T-580-70-66
 - c. Watts Ball Valve 4 inch and larger: G-4000
 - d. Viega ProPress Bronze Ball Valves (where Viega ProPress fittings are used)
 - e. Milwaukee Valve Full Port through 2 inch – BA-400S
 - f. Apollo Ball valve full port through 1-1/2 inch 77CA
 - g. Apollo Ball Valve standard port 3 inch 70
 - h. Apollo Press Bronze Ball valves: 77W
4. Check Valve (All listed must be Lead Free):
 - a. Nibco Check Valve: T - 413 - Y -LF (Teflon Seats)
 - b. Nibco Check Valve 2-1/2 inch and larger: F - 918 – Y -LF (Buna-N disc.)
 - c. Nibco Check Valve 2-1/2 inch and larger: W - 920 -W-LF (Wafer)
 - d. Kitz Y & Check: A-22T
 - e. Kitz 2-1/2 inch and Larger #778 C.I.
 - f. Kitz Wafer Check 2-1/2 inch and Larger #7032
 - g. Milwaukee Valve – 509T
 - h. Apollo Check Valve: 163TLF

- i. Apollo Check Valve 2-1/2 inch and larger: 910FLF
- j. Apollo Press Check Valve: 163TPR-LF
- k. Apollo Check Valve 2 inch and larger 910WE-LF (Wafer)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install valves for shut-off and isolating service at each piece of equipment, at vertical risers, and where shown on the drawings.
- C. Use butterfly valves and ball valves in domestic hot water and domestic cold water systems interchangeable in place of gate and globe valves.
- D. Use butterfly valves and ball valves in circulating water systems, for balancing duty.
- E. Provide drain valves at main shut-off valves and low points of piping and apparatus so the systems can be entirely drained.
 - 1. 1 inch valve for pipes 6 inch and larger.
 - 2. 3/4 inch valve for pipes smaller than 6 inch.
 - 3. Terminate with pipe plug.
 - 4. Drain valves shall be ball valves.
- F. Provide isolation valves in domestic water lines to isolate all equipment, restrooms, hose bibbs, and where shown on the drawings.
- G. Where valves are installed in insulated pipe, valve operator shall have an insert so the lever or handle will not damage the insulation. Install handles so the lever or handles will not damage the insulation.
- H. Provide clearance for installation of insulation and access to valves.
- I. Provide access where valves are not exposed.

3.2 VALVE TAGS

- A. Furnish valves with 1-1/2 inch diameter brass valve tags with stamped, black or red-filled numbers. Service designations shall be 1/4 inch letters, and valve numbers shall be 2 inch letters. Engineer shall approve Service designations. Secure tags to valves by use of brass "S" hooks or brass chain. Secure chain to valve by use of copper or Monel meter seals. Valve tags are not required if the valve is located within 3 feet of the equipment being served and the service is obvious.
- B. Mount charts and drawings listing functions of each valve and its location in a metal and glass frame. Place charts and drawings as directed; in addition, on the record drawings mark the symbols and furnish a valve schedule properly identifying the valve number, service, exact location, the material being piped, and the room number of area that the valve services. This schedule shall be furnished on reproducible drafting paper or film suitable for reproduction on an Ozalid machine. The Owner shall approve the size of drafting paper. Provide a copy of the valve chart in the Operating and Maintenance Manuals.

3.3 PIPE SYSTEMS STRAINERS

SALAS O'BRIEN

VALVES, STRAINERS AND VENTS

22 0523-5

Salas O'Brien Registration #F-4111

Lake Tawakoni Tournament Facility - Restroom, Hardscape,
and Landscape
VAN ZANDT COUNTY, TEXAS
STUDIO RED PROJECT NO. 2002

ISSUE FOR BID
September 8, 2022

- A. Provide strainers in supply piping to circulating pumps, thermostatic mixing valves, before solenoid valves and trap primer valves.

END OF SECTION 22 0523

SECTION 22 0719 - PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install piping insulation, jackets, accessories and covering of specified materials. The insulation shall be used for high and low temperature piping applications including domestic hot and cold water, roof and overflow drain sump bodies and rain leaders, horizontal sanitary drain piping which receives condensate, make-up water and pool heating water.

1.2 QUALITY ASSURANCE

- A. The intent of insulation specifications is to obtain superior quality workmanship resulting in an installation that is absolutely satisfactory in both function and appearance. Provide insulation in accordance with the specifications for each type of service and apply as recommended by the manufacturer and as specified.
- B. An approved contractor for this work under this Division shall be:
 - 1. A specialist in this field and have the personnel, experience, training, skill, and the organization to provide a practical working system.
 - 2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that have served their owners satisfactorily for not less than 3 years.
- C. All piping insulation used on the project inside the building must have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50, as determined by test procedures ASTM E 84, NFPA 255 and UL 723. These ratings must be as tested on the composite of insulation, jacket or facing, and adhesive. Components such as adhesives, mastics and cements must meet the same individual ratings as the minimum requirements and bear the UL label.
- D. Condensation on any insulated piping system is not acceptable.
- E. Replace insulation damaged by either moisture or other means. Insulation that has been wet, whether dried or not, is considered damaged. Make repairs where condensation is caused by improper installation of insulation. Also repair any damage caused by the condensation.
- F. Where existing insulated piping, or other surfaces are tapped, remove existing insulation back to undamaged sections for hot surfaces or to nearest insulation stop for cold surfaces, and replace with new insulation of the same type and thickness as existing insulation. Apply as specified for insulation of the same service.

1.3 APPROVALS

- A. Submit product data on each insulation type, adhesive, and finish to be used in the work. Make the submittal as specified in Division 1 General Requirements and obtain approval before beginning installation. Include product description, list of materials and thickness for each service and location and the manufacturer's installation instructions for each product.
- B. Make a field application of each type of insulation to display the material, quality and application method. Obtain approval of the sample application before proceeding with

installation of the work.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Glass fiber pipe insulation:
 - 1. Johns-Manville Micro-Lok AP-T
 - 2. Owens-Corning ASJ/SSL
 - 3. Knauf ASJ/SSL
- B. Cellular Glass Insulation (Foamglass):
 - 1. Pittsburg Corning
 - 2. Cell-U-Foam
- C. Aluminum Jacketing:
 - 1. Childers
 - 2. Pabco
 - 3. RPR
- D. Fiberglass reinforcing cloth mesh:
 - 1. Perma Glass Mesh
 - 2. Alpha Glass Mesh
 - 3. Childers Chil-Glas
 - 4. Vimasco
- E. Mastics and Adhesives
 - 1. Childers
 - 2. Foster
 - 3. Vimasco
 - 4. Armstrong 520 Adhesive
- F. Elastomeric Insulation
 - 1. Armacell
- G. Weather Resistant Coating
 - 1. WB Armaflex Finish
- H. Glass fiber blanket insulation
 - 1. Manville R-series Microlite FSKL
 - 2. Owens-Corning eD75 or ED100 RKF
 - 3. Knauf 0.75 PCF FSK

2.2 FIBERGLASS PIPE INSULATION

- A. Heavy density, dual temperature fiberglass insulation with factory applied, all service, reinforced vapor barrier jacket having integral laminated vapor barrier. Provide with a factory applied pressure sensitive tape closure system and matching butt strips. Supply in thickness as shown.
 - 1. Thermal conductivity 0.23 @ 75°F mean (ASTM 335).

2.3 ELASTOMERIC INSULATION

- A. Insulation material shall be flexible, closed-cell elastomeric insulation in tubular or sheet

form. Material shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with ASTM E84, latest revision. Sheet material with a thickness greater than $\frac{3}{4}$ " shall have a flame spread rating of 25 or less and a smoke developed rating of 100 or less when tested in accordance with ASTM E84, latest revision. In addition, the product, when tested, shall not melt or drip flaming particles, and the flame shall not be progressive. In addition, all materials shall pass simulated end-use fire test. Minimum $\frac{3}{4}$ " thick.

1. Thermal conductivity 0.27 at 75°F mean (ASTM C177 or C518)

2.4 CELLULAR GLASS INSULATION

A. ASTM C552:

1. "k" value of 0.35 @ 75°F ("ksi" value of 0.047 @ 24°C);
2. 8.0 lb./cu.ft. (128 kg/cu.m.) density

2.5 INSULATION/SHIELD AT HANGERS

A. Field fabricated: Use 360° sections of rigid foamglass insulation that will support the bearing area at hangers and supports. Further support insulation at hangers and supports with a shield of galvanized metal covering at least half of the pipe circumference, and conforming to the schedule. Insulation shall extend at least 1" beyond metal shield on each end. When pipe is guided at top and bottom, metal shields shall cover the whole pipe circumference. Adhere metal shield to insulation so that metal will not slide with respect to insulation with $\frac{1}{2}$ " aluminum bands (2) per shield.

1. Sections of foam glass insulation may be used of the same outside diameter of the adjoining pipe insulation.
2. Minimum thickness of foam glass insulation shall not be less than 1" thick.

B. Pipe saddles: Formed galvanized sheets at each support point for insulated pipe, shaped to fit pipe, and covering bottom half of pipe. Length at saddle shall be not less than twice the insulation outside diameter or more than 22". Provide 18 gauge through 4" pipe and 16-gauge 5" pipe and above.

2.6 SEALANT, ADHESIVE AND FINISH

A. Lap Adhesive. Provide Childers CP-82 adhesive.

B. Vapor Barrier Finish:

1. Indoors: Provide as insulation coating Childers CP-35, white.
2. Outdoors: Provide as insulation coating Childers Encacel X.
3. Underground: Provide Childers CP-22/24 for fittings and areas. Pittwrap cannot be used.

C. Sealant. Provide Childers CP-76 vapor barrier sealant.

D. Lagging Adhesive. Provide Childers CP-50.

E. Other products of equal quality will be acceptable only upon approval.

2.7 ALUMINUM JACKETING

A. Finish insulated piping outdoors with a smooth prefabricated Z-lock aluminum jacket 0.016" thick with factory applied 1 mil polyethylene/40 lb and Fab strap. Kraft moisture barrier. Childers Lock-On or approved equal.

- B. Valves, Fittings and Flanges. For finishing valves, fittings, flanges and similar installations, provide formed aluminum covers, 0.024" thick.
- C. Straps and Seals. Provide ½" x 0.020 stainless steel strapping and seals for jackets and covers according to manufacturer's recommendations.

2.8 GLASS FIBER BLANKET INSULATION

- A. Minimum density of 1.0 PCF, 2" thick, installed R value to be 6.0 or better at 75°F mean, facing of 0.35 mil foil reinforced with glass yarn mesh and laminated to 40 lbs fire resistant kraft.

PART 3 - EXECUTION

3.1 INTERIOR PIPING

- A. Cover all piping with glass fiber, heavy density, dual temperature pipe insulation with a vapor barrier jacket. Apply insulation to clean, dry pipes. Longitudinal seams shall be joined firmly together and sealed with self-sealing lap joints. Butt insulation joints firmly together and seal with a 3" wide ASJ butt strip seal. Longitudinal seams and butt strip laps shall be coated and sealed with CP-35 vapor barrier coating for chilled water piping applications.
- B. Install hanger with protective shield, on the outside of all insulation.
- C. Where domestic water pipes (1/2" & ¾" pipe sizes) are installed on trapeze type hangers, provide galvanized sheet metal protection shields at these locations. Place insulation jacket directly on hanger. Incompressible, load bearing insulation segments are not required.
- D. Pipe Saddles: Formed galvanized sheets at each support point for insulated pipe, shaped to fit pipe, and covering bottom half of pipe. Length at saddle shall be not less than twice the insulation outside diameter. Provide 18-gauge through 4" pipe and 16-gauge for 5" pipe and above.
- E. Seal ends of pipe for drinking chilled water insulation with vapor barrier mastic at valves, flanges, fittings and every 21' on straight runs of piping. Mastic should extend on top of ASJ jacket, across the glass, down onto the pipe making a complete seal.
- F. Apply a smooth flood coat of white lagging Foster 8142W over all exposed insulation.
- G. Piping to be insulated as specified above:
 - 1. All hot and cold water.
 - 2. Make-up water
 - 3. Horizontal sanitary drain piping that receives condensate
 - 4. Exposed to view storm drainage system including roof and overflow drain bodies, vertical piping from drain body and all horizontal rain leaders to first elbow turning down

3.2 PIPING OUTDOORS ABOVE GRADE

- A. Insulate all water piping exterior of building above grade with rigid foam insulation and aluminum jacketing.

- B. Adhere the vapor barrier jacket longitudinal seam with vapor barrier adhesive.
- C. Cover all valves, fittings and flanges with factory made molded or field fabricated segments of pipe insulation of a thickness and material equal to the adjoining insulation. Adhere segments together with no voids, using CP-82 adhesive. Secure fitting insulation covers and segments in place with ½" wide glass filament tape.
- D. Apply a tack coat of fitting mastic over the insulation and tape.
- E. Neatly embed with 10 x 10 fiberglass cloth into the tack coat.
- F. Apply mastic over the fiberglass cloth to a thickness where the fabric is not visible after completion.
- G. Seal ends of pipe insulation with vapor barrier mastic at valves, flanges, fittings and every 21' on straight runs of piping. Mastic should extend on top of ASJ jacket, across the foam, down onto the pipe, making a complete seal.
- H. Finish with aluminum jacketing as specified.

3.3 FLANGE, VALVE AND FITTING INSULATION

- A. Cover valves and flanges with fabricated segments, fittings with two-piece factory molded fittings, and both of matching pipe insulation type and thickness equal to that of the adjoining pipe. Fittings and fabricated segments shall be securely held in place.
 - 1. Apply a tack coat of insulating mastic to the insulated fitting to produce a smooth surface.
 - 2. After mastic is dry, apply a second coat of vapor barrier mastic. Neatly embed with 10 x 10 fiberglass cloth into the tack coat.
 - 3. Overlap mastic and fiberglass cloth by 2" on adjoining sections of pipe insulation.
 - 4. Apply a second coat of mastic over the fiberglass cloth to present a smooth surface.
 - 5. Apply mastic to a wet film thickness of 3/64".
 - 6. Fabric shall not be visible after completion.
 - 7. Vapor seal flanges, valves and fittings with Childers CP-35.
- B. PVC fitting covers are not acceptable.

3.4 ALUMINUM JACKETING (Insulated Piping Outdoors Above Grade)

- A. Apply smooth aluminum jacket on piping, valves, fittings and flange covers according to manufacturer's recommendations, using stainless steel strapping and seals, to provide weather tight covering and to shed water.
- B. Aluminum jacketing is not considered as contributing to the vapor barrier or the insulation jacket. The vapor barrier must be sufficient in itself for this function. Lap each adjoining jacket section a minimum of 3" to make a weather tight seal.
- C. Install straps on 9" centers and at each circumferential lap joint.
- D. Cover and seal all exposed surfaces.
- E. The use of screws and rivets is not approved.

- F. Provide isolation (30# felt) between the aluminum jacket and the sheetmetal protection shield at each pipe support point.

3.5 MISCELLANEOUS

- A. Install materials after piping has been tested and approved.
- B. Apply insulation on clean, dry surfaces only.
- C. Apply weather protective finish on elastomeric insulation installed in non-conditioned spaces. Provide a minimum of three coats.

3.7 INSULATION THICKNESS

<u>INSULATED UNIT</u>	<u>THICKNESS</u> <u>(Inches)</u>
Domestic Cold Water/Make-Up Water Piping/Drinking Chilled Water	1
Horizontal Sanitary Drain Piping Which Receives Condensate	1
Domestic Hot Water Piping, 1-1/2" Pipe and Smaller	1
Domestic Hot Water Piping, 2" Pipe and Larger	1-1/2

END OF SECTION 22 0719

SECTION 22 1116 - DOMESTIC WATER PIPING AND APPURTENANCES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install domestic hot and cold water piping.

1.2 RELATED WORK

- A. Division 22 Plumbing
1. Valves, Strainers and Vents
 2. Pipe and Pipe Fittings - General
 3. Plumbing Piping Insulation
 4. Plumbing Fixtures and Fixture Carriers

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

- A. Below Slab on Grade Piping for Water Entries:
1. 2-inch and smaller, provide ASTM B88 Type K (heavy wall) annealed tempered (soft) seamless copper water tube. No joints below slab entries.
 2. 2-1/2-inch and 3-inch, provide ASTM B88 Type K (heavy wall) annealed tempered (soft) seamless copper water tube, 20 ft. straight lengths. One joint allowed below slab entry using wrought copper, solder-joint pressure fittings: ASME B16.22 with an approved brazing filler metal or pipe can be shop bent for no joint installation by using a "bending" temper tubing.
 3. 4-inch and larger, provide ductile iron pipe with mechanical joints, ANSI A21.6.
- B. Below Grade Piping Outside Building (beyond 5'-0" of building): Provide PVC water main pipe 4 inch through 12 inch in diameter in conformance with AWWA C900. When using 3" or smaller provide Schedule 40 PVC ASTM D1785 with ASTM D-2466 socket type fittings. Provide fittings in conformance with ASTM 2466. Furnish pipe with a minimum pressure rating of 150 lbs. per square inch. Provide PVC pipe as manufactured by Johns-Manville, CertainTeed, Clow or approved equal.
- C. Below Slab on Grade Piping. Furnish ASTM B 88 and ANSI/NSF Standard 61 annealed tempered (soft), Type K copper water tube. Run continuous with no joints under the floor slab. Provide copper pipe corrosion protection as specified in this Section.
- D. Above Slab Piping. Provide seamless ASTM B 88 and ANSI/NSF Standard 61 drawn tempered (hard) Type L copper water tube with wrought copper or bronze fittings with solder-joints, ANSI B16.22. Solder material shall be 95-5 (lead free) (Tin-Antimony-Grade 95TA) ASTM B 32.
- E. Unions. Provide 150 lb. standard unions with ground joint and bronze seat. Flange joints larger than 2 inches. Provide dielectric isolating unions at junctions or connection between metallic piping of dissimilar metal. Provide pipe threads with standard taper pipe threads ANSI B2.1.
- F. Alternate Method of Joining Copper Pipe and Tubing: Press Fittings: Copper press fitting shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM. VIEGA. The system intended for use shall be approved by submittal. Systems from various manufacturers may vary in

technology. The field personnel shall carry training credentials from the approved manufacturer for the project. Mixing of fittings from different manufacturers is strictly prohibited.

2.2 WATER HAMMER ARRESTORS

- A. Provide piston type hydraulic engineered/manufactured water hammer arrestors in cold and hot water supply lines in chases or walls to each fixture branch or battery of fixtures serving quick closing valves of electrical, pneumatic, spring loaded type, or quick hand closure valves on fixture trim. Provide water hammer arrestors at the end of the branch line between the last two fixtures served. Provide Precision Plumbing Products, Inc., or equal. Size units according to water hammer arrestor's Standard PDI WH-201; refer to schedule on drawings.
- B. Install all water hammer arrestors so as to attain 100% effectiveness according to Plumbing and Drainage Institute PDI-WH201 Table 5, 6 and 6-A for water hammer arrestors.
- C. All water hammer arrestors shall be installed in a vertical position.
- D. All water hammer arrestors shall be accessible and shall have access panels where required. Arrestors located above ceilings in fixture drops will not be acceptable. Refer to sizing and placement data as indicated in PDI Standard PDI-WH-201.

PART 3 - EXECUTION

3.1 DRAINAGE

- A. Install water piping systems with uniform horizontal grade of 1/8 inch per 10 foot, minimum, to low points to provide complete system drainage. Where constant pitch cannot be maintained for long runs, establish intermediate low points and rise to new level. Grade branches to drain to mains or risers. Unless otherwise indicated, terminate low points of risers with drain valve piped to nearest hub or floor drain.

3.2 STERILIZATION

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Inject chorine disinfectant in liquid, powder, tablet or gas form throughout the system to obtain 50 to 80 Mg/L residual.
- C. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 20% of the outlets.
- D. Retain disinfectant in system for 8 hours (minimum), 24 hours (maximum). During the disinfection process, operate all valves and accessories.
- E. If final disinfectant residual tests less than 25 Mg/L, repeat treatment.
- F. Flush disinfectant from system until chemical and bacteriological tests prove water quality equal to that of the service main.
- G. Take samples no sooner than 24 hours after flushing from at least 10% of the outlets and from the water entry.
 - 1. Obtain a minimum of one water sample flushing from at least 10% of the outlets

- and from the water entry.
- 2. Take samples from faucets located at highest point in the building, and farthest point from the main water supply.
- H. After final flushing, remove aerators, clean and replace.
- I. Chemical and bacteriological tests shall be conducted by a state certified laboratory.
- J. The firm performing the disinfection shall have chemical laboratory experience.
- K. Provide a laboratory report to indicate the following information.
 - 1. Name and address of the approved laboratory testing the samples.
 - 2. Name and location of the project and date the samples were obtained.
 - 3. Mg/L chlorine during retention.
 - 4. Mg/L chlorine after flushing.
 - 5. The coliform organism count. (An acceptable test shall show absence of coliform organisms.)
- L. If analysis does not satisfy the specified minimum requirements, repeat the disinfection procedure.
- M. Submit for approval to the Architect/Engineer a copy of the laboratory report and the certification of performance. An approved copy of each document shall be inserted in the Owner's manual.

3.3 UNDERGROUND WATER PIPING SYSTEM PROCEDURES

- A. Lay sewer and water lines in separate trenches, separated by 10 foot of undisturbed or compacted soil.

3.4 TESTING

- A. Test under a cold water hydrostatic pressure of 1-1/2 times operating pressure (150 psig minimum) and carefully check for leaks. Repair leaks and retest system until proven watertight.
- B. Test the domestic water piping system at 150psig hydrostatic pressure, maintained for 6 hours.
- C. Use only potable water for the test.
- D. Perform the test before fixtures, faucets, trim or final connections are made to equipment.
- E. If the system is tested in sections, the entire domestic water piping system shall be submitted to a final test, employing the specified procedure.
- F. Do not insulate or conceal piping systems until tests are satisfactorily complete.
- G. If any leaks or other defects are observed, suspend the test and correct the condition at once. Repeat testing until leaks are eliminated and the full test period is achieved.
- H. The satisfactory completion of testing does not relieve the Contractor of responsibility for ultimate proper and satisfactory operation of piping systems and their accessories.

3.5 COPPER PIPE CORROSION PROTECTION

- A. Corrosion protect copper tube piping systems:
 - 1. In the building slab.
 - 2. Beneath the building slab.
 - 3. Buried.
 - 4. Route plasti-sleeve 0.006 thick material entire length of below slab on grade copper tubing.
- B. Cover copper tubing piping system with:
 - 1. "Tapecoat" TC Primer.
 - 2. "Tapecoat" CT cold applied coating tape.
- C. Install coating system as specified by the manufacturer.
- D. Extend the corrosion protection 2 inches above concrete slab on grade.

3.6 TEST OF PIPE CORROSION PROTECTION SYSTEM

- A. Test the pipe corrosion protection coating with an approved high voltage tester adjusted to provide sufficient voltage to produce a spark through a pinhole in the coating (at least 15 kv AC).
- B. Make repairs to small holes in accordance with the manufacturer's instructions.
- C. Retest the repairs using procedures listed above.
- D. Furnish certificate of compliance with field testing in Owner's manual.

END OF SECTION 22 1116

SECTION 22 1316 - SOIL, WASTE AND SANITARY DRAIN PIPING, VENT PIPING AND
APPURTENANCES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install piping in buildings and underground laterals to 5 foot outside of building.

1.2 RELATED WORK

- A. Site Work:
 - 1. Sanitary Sewers
 - 2. Excavation, Trenching and Backfilling for Utilities
- B. Division 22 Plumbing:
 - 1. Pipe and Pipe Fittings
 - 2. Plumbing Fixtures and Fixture Carriers
 - 3. Drains, Cleanouts and Hydrants
 - 4. Earthwork

1.3 REFERENCES

- A. CISPI - Cast Iron Soil Pipe Institute
- B. ASTM - American Society for Testing and Materials

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. All No-Hub clamps must have 4 bands minimum. Sizes 5" through 10" shall have six bands minimum.
 - 1. No-Hub Clamps – Sanitary Waste:
 - a. Husky SD 4000
 - 2. No-Hub Clamps - Vents
 - a. Husky SD – 2000
 - b. Mission Rubber Co., LLC Heavy Weight Couplings
 - 3. Clamp-All Hi-TorQ 80 or approved equal
- B. Provide Fernco "Pro-flex" shielded couplings Series 3000 with one piece neoprene gasket for all cast iron pipe transitions to Schedule 40 DWV pipe penetrations through slabs. Sizes 1-1/2" through 8" Series 3000.
- C. Cast Iron Soil Pipe and Fittings:
 - 1. AB&I
 - 2. Charlotte Pipe and Foundry Co.
 - 3. Tyler Pipe / Soil Division

2.2 DRAIN PIPE AND FITTINGS

- A. Above Slab Pipe:

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1. No-hub cast iron soil pipe and fittings shall conform to CISPI 301 and ASTM A888.
 2. Pipe shall conform to ASTM A74.
 3. No-hub couplings shall meet or exceed the latest specification standard CISPI 310 or ASTM C-1540 and conform to FM 1640. CISPI 310 Couplings shall be listed by NSF International.
 4. Rubber Gaskets for cast iron soil pipe and fittings shall conform to ASTM C564
 5. All Cast Iron Soil Pipe and Fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute
- B. Below Slab on Grade Piping:
1. Schedule 40 PVC plastic pipe and DWV fittings.
 2. Solvent welded DWV joints shall conform to IAPMO Installation Standard IS-9.
 3. Pipe and fittings shall conform to ASTM D 1784, ASTM D 1785, ASTM D 2665, ASTM D 3311 and NPS Standard 14 & 61.

2.3 VENT PIPE AND FITTINGS

- A. Above Slab Pipe:
1. No-hub cast iron soil pipe and fittings shall conform to CISPI 301 and ASTM A888.
 2. Pipe shall conform to ASTM A74.
 3. No-hub couplings shall conform to CISPI 310 and shall be listed by NSF International
 4. Rubber gaskets for cast iron soil pipe and fittings shall conform to ASTM C564
- B. Below Slab on Grade Piping:
1. Provide Schedule 40 PVC with DWV fittings with solvent welded joints. Pipe and fittings shall conform to ASTM D1784-82.
- C. Above Slab Pipe.
1. Drainage-waste-vent copper pipe and fittings for waste stub-outs for all fixture locations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All above and below slab soil, waste, sanitary drain and vent piping installation methods shall be in accordance with Cast Iron Soil Pipe Institute Standards.
- B. Above ground installation in the horizontal position shall be supported at every hub (hub & spigot or hubless type). Hangers are to be placed within 18" of hub or coupling. For large diameter fittings, 5 inches and larger shall be braced to prevent horizontal movement. Every branch opening or change of direction, braces, blocks, rodding or other suitable method shall be used to prevent movement. Riser clamps to be used for each floor, not to exceed 15'-0".
- C. All above and below slab PVC sanitary waste and vent piping installation methods shall be in accordance with IAPMO Installation Standard 18-9 for Schedule 40 PVC-DWV, per manufacturer's recommendations and applicable standards.
- D. Tracer wires shall be installed on all underground PVC sanitary sewer lines installed

outside the building slab.

- E. All PVC underground shall be installed in accordance with ASTM D2321.

3.2 GRADE

- A. Give horizontal pipe grade of 1/4-inch per foot where possible, but not less than 1/8 inch per foot unless otherwise shown.

3.3 DRAIN PIPE AND FITTINGS

- A. Offsets and Fittings.
 - 1. Use reduction fittings to connect two pipes of different diameter.
 - 2. Change directions by appropriate use of 45-degree wyes, long-sweep quarter-bends, and sixth-, eighth-, and sixteenth-bends. Sanitary tees can be used on vertical stacks. Use long sweeps at the base of risers.
 - 3. Provide a separate trap at each fixture, unless a trap is built into the fixture. Provide a deep seal trap at each floor drain and hub drain. Place traps so that the discharge from any fixture will pass through only one trap before reaching a building drain.
 - 4. Refer to Sanitary Drainage Code section for acceptable fittings to be used for changes in direction of drainage flow. Double combo sanitary fittings or double wye and 1/8th bend fittings are not allowed for horizontal to horizontal piping systems per Code.
- B. Hub Drains. Install hub drains where indicated, with the top of the hub 1/2 above the finished floor, unless otherwise indicated on the drawings.
- C. Cleanouts. Install cleanouts the same size as the soil waste lines in which the cleanouts are placed; however, no cleanout should be larger than 4 inches in diameter.
 - 1. Where cleanouts occur in pipe chases, bring the cleanouts through the walls and install covers. Where cleanouts occur in floor slabs, set flush. Reference drawing schedule.
 - 2. Provide cleanouts where soil lines change direction, every 50 foot on long runs, or as shown on the drawings, at the end of each horizontal waste line, and at the base of each riser (and at each increase in pipe size).
 - 3. Cleanouts shall occur at the end of each battery of water closets, urinals, lavatories, sinks, and single water closets. Cleanouts shall be installed so as to access the main sanitary or soil line. Extend and offset above flood rim of water closet.
 - 4. Double sanitary tees and double quarter bends do not allow for easy access to main lines, therefore these types of fittings are not allowed.
- D. Floor Drains. Locate floor drains 1/2-inch below finish floor elevation unless otherwise shown.

3.4 VENT PIPING

- A. Make vent connections to vent stacks with inverted wye fittings. Extend full-size vents through the roof to at least 6 inches above the roof.
- B. Flash the roof penetration with 6 lb. lead flashing approximately 24 inches square. Flange the flashing to the lead sleeve. Extend the flashing up and around the vent pipe. Turn the

flashing down inside the pipe at least 2 inches to make a watertight joint. Flashing shall comply with the roofing manufacturer's requirements. Reference the Architectural Drawings for exact requirements.

- C. Locate vent piping through roof a minimum horizontal distance of not less than 20 feet from any air intake opening or supply fan.

3.5 TESTING

- A. Below Slab on Grade and All Floors in Multi-Story Buildings:
 - 1. Test pipe below slab on grade before backfilling and connecting to city sewers.
 - 2. Maintain not less than 10 foot of hydrostatic head for 1 hour without a leak.
 - 3. Before acceptance of the work the contractor must ensure the piping is in working order before and after the slab is poured. To ensure this the contractor must test completed systems in the presence of the Architect, Engineer and authorities having jurisdiction after installation is complete.
 - 4. Maintain the test on the system till after the slab is poured. Provide an accessible connection that may be reviewed by Architect, Engineer and authorities having jurisdiction prior to and after the slab is poured.
 - 5. Test drainage piping systems in accordance with governing codes and the requirements specified. Provide equipment and materials and make test connections required to execute tests.
 - 6. Test drainage and waste piping hydraulically by filling system to its highest point or, whichever is greater, at a static head of 10 feet. Leaks at any joint shall be sufficient cause for rejection.
 - 7. Air tests may be substituted for hydraulic tests by forcing air into the closed system at a uniform pressure sufficient to balance a column of 10 inch hg in height.
 - 8. Under any of the previously described tests, the water height shall remain constant, after stabilization, for not less than 15 minutes without any further addition of water.
- B. System Test. After the various sections of soil, waste and vent piping are installed, but before fixtures are connected, test the system by:
 - 1. Plugging outlets.
 - 2. Filling vertical sections of multiple story buildings of not less than three floors at a time with water. Provide wyes as required to facilitate plugging.
 - 3. Test for 6 hours without any drop in the water level.

3.6 RODDING SEWERS

- A. All sanitary soil and waste lines, both in the building and out, shall be rodded out and flushed out after completion of construction and prior to finish floor being installed. All work must be completed prior to substantial completion. All floor drains and cleanout locations must be included in this work.
- B. All sanitary soil and waste lines below building 3" and larger shall be internally videotaped at time of substantial completion. All videotaping shall include on-screen date and time, and include audio narration. All videotaping shall be provided by experienced individual in videotaping piping systems. An Owner's Representative shall be present during videotaping. Three copies of the videotape shall be delivered to the Owner for future records.
- C. This work shall be done in the presence of the Owner's Representative, as part of the Contract, to ensure all lines are clear, and any obstruction that may be discovered shall

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be removed immediately. Rodding shall be accomplished by utilizing the proper rotary head to clear sewer. Pipe sizes 8 inches and larger shall be hydro-flushed.

END OF SECTION 22 1316

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SECTION 22 2000 - PLUMBING PIPE AND PIPE FITTINGS - GENERAL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install pipe and pipe fittings for piping systems specified in Division 22 - Plumbing.

1.2 RELATED WORK

- A. Division 22 Plumbing
 - 1. Earthwork
 - 2. Valves, Strainers and Vents
 - 3. Insulation
 - 4. Other Piping Sections

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. The particular type of pipe and fittings for each system is specified in the individual sections.

2.2 JOINTS

- A. Make screwed joints using machine cut USASI taper pipe threads. Apply a suitable joint compound to the male threads only. Ream the pipe to full inside diameter after cutting. All-thread nipples are not permitted.
- B. Dissimilar Metals. Make joints between copper and steel pipe and equipment using insulating unions or couplings such as Crane Company #1259; EPCO as manufactured by EPCO Sales, Inc.; or an approved equal.
- C. Solder joints.
 - 1. Prior to making joints, cut pipe square and ream to full inside diameter. Clean exterior of pipe and socket. Apply a thin coat of suitable fluxing compound to both pipe and socket, and fit parts together immediately.
 - 2. Heat assembled joint only as required to cause the solder to flow. Run the joint full, slightly beaded on the outside, and wipe to remove excess solder.
 - 3. Use silver brazing alloy or Sil-Fos on underground water entry piping. Use lead free solder on all other copper piping.
- D. Make welded joints as recommended by the standards of the American Welding Society. Ensure complete penetration of deposited metal with base metal. Provide filler metal suitable for use with base metal. Keep inside of fittings free from globules of weld metal. The use of mitered joints is not approved.
- E. Flanged.
 - 1. Prior to installation of bolts, center and align flanged joints to prevent mechanical pre-stressing of flanges, pipe or equipment. Align bolt holes to straddle the vertical, horizontal or north-south centerline. Do not exceed 3/64" per foot inclination of the flange face from true alignment.
 - 2. Use flat-face companion flanges only with flat-faced fittings, valves or equipment. Otherwise, use raised-face flanges.

3. Install gaskets suitable for the intended service and factory cut to proper dimensions. Secure with manufacturers recommended gasket cement.
 4. Use ANSI nuts and bolts, galvanized or black to match flange material. Use ANSI 316 stainless steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Draw bolts tight to ensure proper seating of gaskets.
 5. Use carbon steel flanges conforming to ANSI B16.5 with pipe materials conforming to ASTM A 105 Grade II or ASTM A 108, Grade II, ASTM A 53, Grade B. Use slip-on type flanges on pipe only. Use welding neck type flanges on all fittings. Weld slip-on flanges inside and outside.
 6. Keep flange covers on equipment while fabricating piping. Remove when ready to install in system.
- F. No Hub. Hubless joints shall be made with wide body, neoprene sealing sleeve with stainless steel sleeve, coupling joints conforming to ASTM C 1277.
1. 4" pipe size and smaller coupling housing minimum of 3" width; 24 gauge Series 300 stainless steel with hi-torque clamps; neoprene coupling gasket.
 2. 6" through 10" pipe size coupling housing minimum of 4" width.
 3. Tighten clamps to within manufacturer's tolerances using preset torque wrench.
- G. Mechanical Joints. Provide a stuffing box type mechanical joint adapted to use gasket, cast iron gland and bolts. Coat bolts with bitumastic enamel. Use joint parts similar in design to one of the following:
1. Duplex Simplex Joint manufactured by the American Cast Iron Pipe Company, Birmingham, Alabama.
 2. U.S. joints manufactured by the United States Pipe and Foundry Company, Burlington, New Jersey.
 3. Boltite Joint manufactured by the McWane Cast Iron Pipe Company, Birmingham, Alabama.
 4. Flexlamp manufactured by the National Cast Iron Pipe Company, Birmingham, Alabama.
- H. Compression Joints for Cast Iron Water Pipe. Use Beltite, Tyton or Grip-Tite compression joints. Install in accordance with the manufacturer's recommendations for compression joints. Provide adequate concrete thrust blocks at changes of direction, as recommended by the manufacturer.
- I. Compression Gasket System. Bell and spigot cast iron pipe 4" and smaller, use flax-base lubricant, Tyler Ty-Seal Lubricant or Charlotte Regular Lubricant. 6" and larger use a neoprene base lubricant, Charlotte Adhesive Lubricant.
- J. Press fittings for copper pipe 1/2" to 4": Copper press fittings shall conform to the material and sizing requirements of ASTM B16.18 or ASME B16.22. O-rings for copper press fittings shall be EPDM. Pro-Press System manufactured by VIEGA. The system intended for use shall be approved by submittal. Systems from various manufacturers may vary in technology. The field personnel shall carry training credentials from the approved manufacturer for the project. Mixing of fittings from different manufacturers is strictly prohibited.
- K. Press fittings for steel pipe 1/2" to 2": Where accepted by local code for specific applications, Cold Press Mechanical Joint Fittings shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria of ANSI/CSA LC4. Sealing system shall be EPDM or HNBR as appropriate for a defined application. MegaPress system manufactured by VIEGA or approved equal and include "Smart Connect" assurance that unpressed fittings will not hold pressure. The system intended for use shall be approved by submittal. Systems from various manufacturers may vary in

technology. The field personnel shall carry training credentials from the approved manufacturer for the project. Mixing of fittings from different manufacturers is strictly prohibited.

2.3 UNIONS

- A. Use 150 lb. standard (300 lb. WOG) malleable iron, ground joint unions with bronze seat. Provide flanged joints on piping 2-1/2" and larger.
 - 1. Where pipe materials of different types join, use a dielectric union. Union shall be threaded, solder or as required for its intended use.

2.4 BRANCH CONNECTIONS

- A. Pipe 2" and Smaller. For threaded piping, use straight size reducing tee. When branch is smaller than header, a nipple and reducing coupling or swagged nipple may be used.
- B. 2-1/2" through 36": For welding piping, when branch size is the same as header size, use welding tee. Use Weld-o-let when branch is smaller than header. For threaded branch connections, use 3000 lb. full coupling or Thread-o-let welded to header.

2.5 GASKETS

- A. High Temperature Piping. Provide 1/16" thick ring gaskets of aramid reinforced SBR such as Garlock #3200 or 3400 or equal by Advanced Products and Systems.
- B. Other Piping. Provide ring rubber gaskets, Garlock #7992 or equal by Advanced Products and Systems. Use 1/8" thick cloth reinforced neoprene gaskets. For smaller than 6", use 1/16" thick gasket.

2.6 FLOORS AND CEILING PLATES

- A. Provide chrome-plated floor and ceiling plates around pipes exposed to view when passing through walls, floors, partitions, or ceilings in finished areas; size plates to fit pipe or insulation and lock in place.

2.7 DOMESTIC MANUFACTURE

- A. All piping material, pipe and pipe fittings shall be manufactured in the United States of America unless specifically named in these specifications.

PART 3 - EXECUTION

3.1 PIPE FABRICATION AND INSTALLATION

- A. Make piping layout and installation in the most advantageous manner possible with respect to headroom, valve access, opening and equipment clearance, and clearance for other work. Give particular attention to piping in the vicinity of equipment. Preserve the required minimum access clearances to various equipment parts, as recommended by the equipment manufactured, for maintenance.
- B. Cut all pipes to measurement determined at the site. After cutting pipe, remove burrs by reaming. Bevel plain ends of ferrous pipe.
- C. Install piping neatly, free from unnecessary traps and pockets. Work into place without springing or forcing. Use fittings to make changes in direction. Field bending and mitering

is prohibited. Make connections to equipment using flanged joints, unions or couplings. Make reducing connections with reducing fittings only.

- D. Install piping without tapping out of the bottom of pipe.
- E. Press Connections: Copper and steel press fittings ½" through 4" shall be applied in accordance with the manufacturer's installation instructions. The tubing/pipe shall be fully inserted into the fitting and the tubing/pipe marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing/pipe to assure the tubing/pipe is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer. If soldering (thread adapters, etc.) near press fittings, take precautions to not damage the O-ring fittings. Maintain three pipe diameters or use a cooling agent. Viega-"Pro-Press".

3.2 WELD

- A. Weld and fabricate piping in accordance with ANSI Standard B31.1, latest edition, Code for Pressure Piping.
- B. Align piping and equipment so that no part is offset more than 1/16". Set fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
- C. Do not permit any weld to project within the pipe so as to restrict flows. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.
- D. Do not split, bend, flatten or otherwise damage piping before, during or after installation.
- E. Remove dirt, scale and other foreign matter from inside piping before tying into existing piping sections, fittings, valves or equipment.
- F. Bevel ends of ferrous pipe.

3.3 OFFSETS AND FITTINGS

- A. Due to the small scale of drawings, the indication of offsets and fittings is not possible. Investigate the structural and finish conditions affecting the work and take steps required to meet these conditions.
- B. Install pipe close to walls, ceilings and columns so pipe will occupy minimum space. Provide proper spacing for insulation coverings, removal of pipe, special clearances, and offsets and fittings.

3.4 SECURING AND SUPPORTING

- A. Support piping to maintain line and grade, with provision for expansion and contraction. Use approved clevis-type or trapeze-type hangers connected to structural members of the building. Single pipe runs to be supported by approved clevis type hangers. Multiple pipe runs to be supported by approved trapeze type hangers. Do not support piping from other piping or structural joist bridging.
- B. Provide supports both sides of elbows for pipe 6" and larger.
- C. Support vertical risers with steel strap pipe clamps of approved design and size,

supported at each floor. Support piping assemblies in chases so they are rigid and self-supported before the chase is closed. Provide structural support for piping penetrating chase walls to fixtures. On cold water pipe, supports shall be outside the insulation.

- D. Where insulation occurs, design hangers to protect insulation from damage. Pipe saddles and insulation shields, where required, are specified in the appropriate insulation section and are sized in accordance with the schedule on the drawings.
- E. Install trapeze hangers, properly sized, to support the intended load without distortion.
- F. Use electro-galvanized or zinc plated threaded rods, nuts, washers and hangers.
- G. At outdoor locations, all supports, brackets and structural members shall be hot-dipped galvanized.
- H. Support spacing: As recommended by the project structural engineer and support manufacturer, but not more than listed below. Not to exceed spacing requirements of smallest pipe.

Pipe Size	Copper & Steel Max. Support Spacing, Feet	Cast Iron Max. Support Spacing, Ft.	Minimum Rod Diameter, Inches
1" & smaller	6		3/8
1-1/4" & 1-1/2"	8	5	3/8
2"	10	5	3/8
3"	10	5	1/2
4" & 5"	10	5	5/8
6" and above	10	5	3/4

3.5 PIPE SUPPORTS

- A. Provide P1001 or P 5000 Unistrut metal framing members and appurtenances for pipe support. Hot-dip galvanize members and appurtenances when located outside. Sagging of pipes or supports is not acceptable.
- B. Adjustable clevis hangers shall be used for single pipe supports; Anvil Fig. 260. When oversized clevis is used, a nipple shall be placed over the clevis bolt as a spacer to assure that the lower U-strap will not move in on the bolt. Provide adjustable clevis with a nut / washer above and below the hanger on the support rod. Ring type clevis hangers are not acceptable.
- C. Provide Anvil Figure 45 galvanized or primed and painted channel assembly for trapeze hangers.

3.6 PIPE SUPPORTS ON ROOF

- A. Support gas pipe on roof with Portable Pipe Hanger Model PP-10 with roller and fully adjustable height throughout pipe run. Base material shall be high density / high impact polypropylene with UV inhibitors and anti-oxidants. Provide with hot dip galvanized rod finish and framing. Nuts and washers shall be hot dip galvanized.

3.7 ANCHORS

- A. Provide anchors as required. Use pipe anchors consisting of heavy steel collars with lugs

and bolts for clamping to pipe and attaching anchor braces. Install anchor braces in the most effective manner to secure desired results. Do not install supports, anchors or similar devices where they will damage construction during installation or because of the weight or the expansion of the pipe. When possible, install sleeves in structural concrete prior to pouring of concrete.

3.8 FLOOR PENETRATIONS

- A. At locations where pipe passes through floors, provide watertight concrete curb around penetration.

3.9 PIPE SLEEVES

- A. Sleeves through masonry and concrete construction:
 - 1. Fabricate sleeves of Schedule 40 galvanized steel pipe.
 - 2. Size sleeve large enough to allow for movement due to expansion and to provide continuous insulation.
- B. Sleeves through gypsum wall construction.
 - 1. Fabricate sleeves of 16 gauge galvanized sheet metal.
- C. Sleeves through elevated slab construction.
 - 1. Fabricate sleeves of Schedule 40 galvanized steel pipe with welded center flange in floor.
- D. Extend each sleeve through the floor or wall. Cut the sleeve flush with each wall surface. Sleeves through floors shall extend 2" above floor lines for waterproofing purposes. Slab on grade floors shall not be sleeved except where penetrating waterproofing membrane or insect control is required.
- E. Caulk sleeves water and air tight. Seal annular space between pipes and sleeves with mastic compound to make the space water and air tight.
- F. For sleeves below grades in outside walls, provide Thunderline Link-Seal or Advance Product and System Interlynx, with 316 stainless steel nuts and bolts, with cast iron pressure plate.
- G. Provide chrome plated escutcheon plates on pipes passing through walls, floors or ceilings exposed to view. At exterior walls, stainless steel sheet metal is to be used.
- H. For sleeves through fire and smoke rated walls, seal with a UL through-penetration firestop, rated to maintain the integrity of the time rated construction. Install in accordance with the manufacturer's installation instructions. Comply with UL and NFPA standards for the installation of firestops. Refer to Architectural drawings for all fire and smoke rated partitions, walls, floors, etc.

3.10 ISOLATION VALVES

- A. Provide piping systems with line size shutoff valves located at the risers, at main branch connections to mains for equipment, to isolate central plant, and at other locations.

3.11 DRAIN VALVES

- A. Install drain valves at low points of water piping systems so that these systems can be entirely drained. Install a line size drain valve for pipes smaller than 2" unless indicated

otherwise. For pipes 2-1/2" and larger, provide 2" drain valves unless indicated otherwise. Drain valves shall be plugged when not in use and at completion.

3.12 CLEANING OF PIPING SYSTEMS

- A. General cleaning of piping systems. Purge pipe of construction debris and contamination before placing the systems in service. Provide and install temporary connections as required to clean, purge and circulate.
- B. Install temporary strainers at the inlet of pumps and other equipment as necessary where permanent strainers are not indicated. Keep strainers in service until the equipment has been tested, then remove either entire strainer or straining element only. Fit strainers with a line size blow down ball valve and pipe to nearest drain. Blow down strainers, remove and clean as frequently as necessary.
- C. Phase One: Initial flushing of system. Remove loose dirt, mill scale, weld beads, rust and other deleterious substances without damage to system components. Open valves, drains, vents and strainers at all system levels during flushing procedures. Flush until "potable water clear" and particles larger than 5 microns are removed.
- D. Connect dead-end supply and return headers, even if not shown on the drawings, and provide terminal drains in bottom of pipe end caps or blind flanges.
- E. Dispose of water in approved manner.
- F. Phase Two: Cleaning of Piping Systems. Remove, without chemical or mechanical damage to any system component, adherent dirt (organic soil), oil, grease, (hydrocarbons), soldering flux, mill varnish, piping compounds, rust (iron oxide) and other deleterious substances not removed by initial flushing. Flush system and replace with clean water.
- G. Phase Three: Final flushing and rinsing: Flush and rinse until "potable water clear" and particles larger than 5 microns are removed. Operate valves to dislodge any debris in valve body. Dispose of water in approved manner.
- H. Submit status reports upon completion of each phase of work on each system.

3.13 TESTING

- A. Test piping after installation with water hydrostatic pressure of 1-1/2 times operating pressure (150 psig minimum) and carefully check for leaks. Repair leaks and retest system until proven watertight.
- B. Do not insulate or conceal piping systems until tests are satisfactorily complete.
- C. If any leaks or other defects are observed, suspend the test and correct the condition at once. Repeat testing until leaks are eliminated and the full test period is achieved.
- D. The satisfactory completion of testing does not relieve the Contractor of responsibility for ultimate proper and satisfactory operation of piping systems and their accessories.

3.14 PIPE MARKERS

- A. Identify interior exposed piping and piping in accessible chases or plenums with Opti-Code Brady Pressure Sensitive Adhesive Pipe Markers, consisting of pipe marker and direction of flow arrow tape. Clean pipe prior to installation. Background colors of markers, arrows and tape for each type of system shall be the same. Meet ANSI/OSHA standards and clearly identify each system. Provide minimum 2-1/4-inch letters through 4-inch pipe and 4-inch letters for 5-inch pipe and larger.
- B. Identify exterior and mechanical room piping with Snap Around pipe markers through 4-inch pipe and Strap Around markers 5-inch pipe and larger. Pipe markers consisting of pipe marker and direction of flow arrow tape; background colors of markers, arrows and type for each type of system shall be the same. Meet ANSI / OSHA standards and clearly identify each system. Provide minimum 2-1/4-inch letters through 4-inch pipe and 4-inch letters for 5-inch pipe and larger.
- C. Install identification in the following locations:
 - 1. Both sides of penetrations through walls, floors and ceilings.
 - 2. Close to valves or flanges.
 - 3. Intervals on straight pipe runs not to exceed 50 feet
 - 4. Apply marker where view is obstructed.
- D. Pipe markers shall meet or exceed the specifications of the ASME A13.1 "Scheme for Identification of Piping Systems".

END OF SECTION 22 2000

SECTION 22 3313 - TANKLESS ELECTRIC WATER HEATER

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Tankless electric water heaters for domestic water systems.

1.2 RELATED WORK

- A. Division 22 Plumbing
 - 1. Domestic Water Piping.
 - 2. Plumbing Piping Insulation.
 - 3. Division 26 Electrical.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Chronomite
- B. EEMAX

2.2 PRODUCTS

- A. Provide tankless, flow switch activated heater.
- B. Hot water temperature range of 103°F to 120°F.
- C. 0.5 GPM flow rate.
- D. Low pressure model if required. Contractor shall verify pressure at site.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install where shown on Drawings and in accordance with manufacturer's requirements.

3.2 WARRANTY

- A. Provide standard manufacturer's 1 year commercial warranty for mechanical and electrical and 5 year warranty for leaks. Warranty shall start the date of the substantial completion certificate.

END OF SECTION

SECTION 22 4000 - PLUMBING FIXTURES AND FIXTURE CARRIERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install water closets, urinals, lavatories, electric drinking fountains, fixture carriers and plumbing appurtenances.

1.2 RELATED WORK

- A. Division 22 Plumbing
 1. Drains, Hydrants and Cleanouts.
 2. Domestic Water Piping.
 3. Soil, Waste and Sanitary Drain Piping and Vent Piping.

1.3 JOB REQUIREMENTS

- A. Furnish plumbing fixtures and trim as shown and specified. Provide faucets, fittings, supply stops and similar devices of a single manufacturer. Furnish faucets and supply stops with renewable seats. Porcelain to steel and enameled cast iron fixtures shall be acid resistant. Wall hung fixtures shall be installed with a fixture carrier.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Plumbing Fixtures (Vitreous China):
 1. American Standard.
 2. Kohler.
 3. Toto
 4. Zurn
- B. Plumbing Faucets:
 1. American Standard.
 2. Chicago.
 3. T&S Brass.
 4. Zurn.
- C. Supports and Carriers:
 1. Wade
 2. Zurn
 3. J.R. Smith.
 4. Josam.
 5. Watts
 6. MIFAB
- D. Flush Valves:
 1. Sloan
 2. Zurn
- E. Supplies, Stops and Chrome Plated Tubular Brass:
 1. McGuire
 2. Kohler
 3. Chicago

- 4. Zurn

- F. Water Closet Seats:
 - 1. Beneke
 - 2. Church
 - 3. Olsonite
 - 4. Bemis

- G. Electric Drinking Fountains:
 - 1. Halsey Taylor
 - 2. Elkay
 - 3. Oasis
 - 4. Haws

- H. Floor Drains:
 - 1. Wade
 - 2. J.R. Smith
 - 3. Josam
 - 4. Zurn
 - 5. Watts
 - 6. MIFAB

- I. Cleanouts:
 - 1. Wade
 - 2. J.R. Smith
 - 3. Josam
 - 4. Zurn
 - 5. Watts
 - 6. MIFAB

- J. Shower Valves
 - 1. Chicago
 - 2. Acorn
 - 3. Symmons
 - 4. Bradley
 - 5. Moen Commercial

- K. Stainless Steel Sinks:
 - 1. Elkay
 - 2. Just

- L. Mop Sinks:
 - 1. Crane Fiat
 - 2. Stern Williams

- M. Roof Drains:
 - 1. Wade
 - 2. J.R. Smith
 - 3. Josam
 - 4. Zurn
 - 5. Watts
 - 6. MIFAB

- N. Thermostatic Mixing Valves
 - 1. Lawler

2. Symmons
 3. Powers
 4. Bradley
- O. Emergency Safety Equipment
1. Speakman
 2. Bradley
 3. Encon
 4. Guardian
- P. Shock Arrestors:
1. Precision Products
 2. Sioux Chief
- Q. Backflow Preventors
1. Watts
 2. Febco
 3. Wilkins
- R. Hose Bibbs
1. Wade
 2. Chicago
 3. Josam
 4. Woodford
 5. Zurn
 6. J.R. Smith
 7. MIFAB
- S. Wall Hydrants
1. Wade
 2. Woodford
 3. Zurn
 4. J.R. Smith
 5. Josam
 6. MIFAB

2.2 REQUIREMENTS

- A. Refer to the drawings for equipment to be supplied.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with the manufacturer's instructions.
- B. Make rough-in and final connection of service to each fixture provided under this Section and other Sections or Architectural or Plumbing Drawings.
- C. Provide necessary stops, valves, traps, unions, vents, cold water, hot water, sanitary, etc. for a complete installation.
- D. Provide isolation valves in domestic water lines to isolate all equipment, restrooms, hose bibbs, and where shown on drawings.

- E. Remove piping and services roughed-in incorrectly and install correctly, without cost.
- F. Exposed piping, fittings and appurtenances shall be chrome-plated brass.
- G. Coordinate with the Contractor for locations and service required for each plumbing fixture.
- H. All floor drains and floor sinks shall have trap primer connections. Provide trap primer valves and 1/2-inch water line to each floor drain connection. Trap primer supply line shall have ball valve and Y strainer on inlet side of trap primer valve to facilitate cleaning.
- I. All floor drains and floor sink locations are to be coordinated with all equipment. Locate drains in mechanical equipment spaces to conform to drain locations of equipment furnished. Coordinate drain location with food service equipment and Architectural Drawings.
- J. All floor drains, floor sinks and cleanout covers are to be provided with stainless steel vandal resistant screws.
- K. Trap primer valves installed in concealed spaces shall have approved access doors for accessibility.

END OF SECTION 22 4000

SECTION 23 0100 - HVAC OPERATING AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Compilation product data and related information appropriate for Owner's operation and maintenance of products furnished under Contract. Prepare operating and maintenance data as specified.
- B. Instruct Owner's personnel in operation and maintenance of equipment and systems.
- C. Submit three copies of complete manual in final form.

1.2 SUBMITTALS

- A. Thirty (30) days after the Contractor has received the final scheduled identified submittals bearing the Architect/Engineer's stamp of acceptance (including resubmittals), submit for review one copy of the first draft of the Operating and Maintenance Manual. This copy shall contain as a minimum:
 - 1. Table of Contents for each element.
 - 2. Contractor information.
 - 3. All submittals, coordination drawings and product data, reviewed by the Architect/Engineer; bearing the Architect/Engineer's stamp of acceptance. (When submittals are returned from Engineer "Correct as Noted", corrected inserts shall be included.)
 - 4. All parts and maintenance manuals for items of equipment.
 - 5. Warranties (without starting dates)
 - 6. Certifications that have been completed. Submit forms and outlines of certifications that have not been completed.
 - 7. Operating and maintenance procedures.
 - 8. Form of Owner's Training Program Syllabus (including times and dates).
 - 9. Control operations/equipment wiring diagrams.
 - 10. Schedule of filters for each item of equipment.
 - 11. Schedule of belts for each item of equipment.
 - 12. Other required operating and maintenance information that are complete.
- B. Copy will be returned to the Contractor within 15 days with comments for corrections.
- C. Submit three (3) completed manuals in final form to the Architect/Engineer one day after substantial completion, and prior to Owner's instructions. Include all specified data, test and balance reports, drawings, dated warranties, certificates, reports, along with other materials and information.
- D. The Architect/Engineer will review the manuals for completeness within fifteen (15) days.
- E. The Contractor shall be notified of any missing or omitted materials. The Manuals shall be reworked by the Contractor, as required, in the office of the Architect / Engineer. The manuals will not be retransmitted.
- F. Two (2) complete Manuals will be delivered to the Owner.

PART 2 - PRODUCTS

2.1 BINDERS

SALAS O'BRIEN

HVAC OPERATING AND MAINTENANCE MANUALS

23 0100-1

Salas O'Brien Registration #F-4111

- A. Commercial quality black three-ring binders with clear overlay plastic covers.
- B. Minimum ring size: 1".
Maximum ring size: 3".
- C. When multiple binders are used, correlate the data into related groupings.
- D. Label contents on spine and face of binder with full size insert. Label under plastic cover.

PART 3 - EXECUTION

3.1 OPERATION AND MAINTENANCE MANUAL

- A. Form for Manuals:
 - 1. Prepare data in form of an instructional manual for use by Owner's personnel.
 - 2. Format:
 - a. Size: 8-1/2" x 11".
 - b. Text: Manufacturer's printed data or neatly typewritten.
 - 3. Drawings:
 - a. Provide reinforced punched binder tab and bind in text.
 - b. Fold larger drawings to size of text pages.
 - 4. Provide flyleaf indexed tabs for each separate product or each piece of operating equipment.
 - 5. Cover: Identify each volume with typed or printed title "Operating and Maintenance Instructions". List:
 - a. Title of Project
 - b. Identity of separate structures as applicable.
 - c. Identity of general subject matter covered in the manual.
 - 6. Binder as specified.
- B. Content of Manual:
 - 1. Neatly typewritten Table of Contents for each volume arranged in systematic order as outlined in the specifications.
 - a. Contractor, name of responsible principal, address and telephone number.
 - b. A list of each product required to be included, indexed to content of the volume.
 - c. List with each product, name, address and telephone number of:
 - 1) Subcontractor or installer.
 - 2) Maintenance contractor as appropriate.
 - 3) Identify area of responsibility of each.
 - 4) Local source of supply for parts and replacement.
 - d. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
 - 2. Product Data:
 - a. Include those sheets pertinent to the specific product.
 - b. Annotate each sheet to:
 - 1) Identify specific product or part installed.
 - 2) Identify data applicable to installation.
 - 3) Delete references to inapplicable information. (All options not supplied with equipment shall be marked out indicated in some manner.
 - 3. Drawings:
 - a. Supplement product data with drawings as necessary to illustrate:

- 1) Relations of component parts of equipment and systems.
 - 2) Control and flow diagrams.
 - b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
 - c. Do not use Project Record Documents as maintenance drawings.
 4. Written text, as required to supplement product data for the particular installation:
 - a. Organize in consistent format under separate headings for different procedures.
 - b. Provide logical sequence of instructions for each procedure.
 5. Copy of each warranty, bond and service contract issued.
 - a. Provide information sheet for Owner's personnel, giving:
 - 1) Proper procedures in event of failure.
 - 2) Instances that might affect validity of warranties or bonds.
 6. Shop drawings, coordination drawings and product data as specified.
- C. Sections for Equipment and Systems.
 1. Content for each unit of equipment and system as appropriate:
 - a. Description of unit and component parts.
 - 1) Function, normal operating characteristics, and limiting conditions.
 - 2) Performance curves, engineering data and tests.
 - 3) Complete nomenclature and commercial number of replaceable parts.
 - b. Operating procedures:
 - 1) Start up, break-in, routine and normal operating instructions.
 - 2) Regulation, control, stopping, shut down and emergency instructions.
 - 3) Summer and winter operating instructions.
 - 4) Special operating instructions.
 - c. Maintenance procedures:
 - 1) Routine operations
 - 2) Guide to trouble-shooting.
 - 3) Disassembly, repair and reassembly.
 - 4) Alignment, adjusting and checking.
 - 5) Routine service based on operating hours.
 - d. Servicing and lubrication schedule. List of lubricants required.
 - e. Manufacturer's printed operating and maintenance instructions.
 - f. Description of sequence of operation by control manufacturer.
 - g. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
 - 1) Predicted life of part subject to wear.
 - 2) Items recommended to be stocked as spare parts.
 - h. As installed control diagrams by controls manufacturer.
 - i. Complete equipment internal wiring diagrams.
 - j. Schedule of filters for each air handling system.
 - k. Schedule of belts for each item of equipment.
 - l. Each Contractor's coordination drawings.
 - m. As installed color coded piping diagrams.
 - n. Charts of valve tag number, with location and function of each valve.
 - o. List of original manufacturer's spare parts and recommended quantities to be maintained in storage.
 - p. Other data as required under pertinent sections of the specifications.
 2. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
 3. Additional requirements for operating and maintenance data as outlined in

- respective sections of specifications.
4. Provide complete information for products specified in Division 23.
 5. Provide certificates of compliance as specified in each related section.
 6. Provide start up reports as specified in each related section.
 7. Provide signed receipts for spare parts and material.
 8. Provide training report and certificates.
 9. Provide extended compressor warranty certificates.

END OF SECTION 23 0100

SECTION 23 0500 - MECHANICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Except as modified in this Section, General Conditions, Supplementary Conditions, applicable provisions of the General Requirements, and other provisions and requirements of the contract documents apply to work of Division 23 Mechanical.
- B. Applicable provisions of this section apply to all sections of Division 23, Mechanical.

1.2 CODE REQUIREMENTS AND FEES

- A. Perform work in accordance with applicable statutes, ordinances, codes and regulations of governmental authorities having jurisdiction.
- B. Mechanical work shall comply with applicable inspection services:
 - 1. Underwriters Laboratories
 - 2. National Fire Protection Association
 - 3. State Health Department
 - 4. Local Municipal Building Inspection Department
 - 5. Texas Department of Licensing & Regulations (ADA)
- C. Resolve any code violations discovered in contract documents with the Engineer prior to award of the contract. After Contract award, any correction or additions necessary for compliance with applicable codes shall be made at no additional cost to the Owner.
- D. This Contractor shall be responsible for being aware of and complying with asbestos NESHAP regulations, as well as all other applicable codes, laws and regulations.
- E. Obtain all permits required.

1.3 CONTRACTOR'S QUALIFICATIONS

- A. An approved contractor for the work under this division shall be:
 - 1. A specialist in this field and have the personnel, experience, training, skill, and organization to provide a practical working system
 - 2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that has served their Owners satisfactorily for not less than 3 years

1.4 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, or AWWA Specifications; Federal Standards; or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Requirements in reference specifications and standards are minimum for all equipment, material, and work. In instances where specified capacities, size, or other features of equipment, devices, or materials exceed these minimums, meet specified capacities.

1.5 CONTRACT DRAWINGS

- A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of

various elements of work. Determine exact locations from field measurements.

1.6 PROJECT RECORD DOCUMENTS

- A. Maintain at the job site a separate set of white prints (black line) of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings. Mark the drawings with a colored pencil. Prepare, as the work progresses and upon completion of work, reproducible drawings clearly indicating locations of various lines, valves, ductwork, traps, equipment, and other pertinent items, as installed. Include flow-line elevation of sewer lines. Record existing and new underground and under slab piping with dimensioned locations and elevations of such piping.
- B. At the conclusion of project, obtain without cost to the Owner, erasable mylars of the original drawings and transfer as-built changes to these. Prior to transmittal of corrected drawings, obtain 3 sets of blue-line prints of each drawing, regardless of whether corrections were necessary and include in the transmittal (2 sets are for the Owner's use and one set is for the Architect/Engineer's records). Delivery of these as-built prints and reproducible is a condition of final acceptance. Provide record drawings on one set each (reproducible Dayrex mylar film positives) and AutoCad 2014 / Revit CAD files on disk (CD Rom).
- C. As-Built drawings should indicate the following information as a minimum:
 - 1. Indicate all addendum changes to documents.
 - 2. Remove Engineer's seal, name, address and logo from drawings.
 - 3. Mark documents RECORD DRAWINGS.
 - 4. Clearly indicate: DOCUMENT PRODUCED BY
 - 5. Indicate all changes to construction during construction. Indicate actual routing of all piping, ductwork, etc. that were deviated from construction drawings.
 - 6. Indicate exact location of all underground mechanical piping and elevation.
 - 7. Indicate exact location of all underground electrical raceways and elevations.
 - 8. Correct schedules to reflect (actual) equipment furnished and manufacturer.
 - 9. Location and size of all ductwork and mechanical piping above ceiling including exact location of isolation of domestic and mechanical valves.
 - 10. Exact location of all electrical equipment in and outside of the building.
 - 11. Exact location of all roof mounted equipment, wall, roof and floor penetrations.
 - 12. Cloud all changes.

1.7 SPACE REQUIREMENTS

- A. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material that is not suitable in this respect.

1.8 RELATION WITH OTHER TRADES

- A. Carefully study all matters and conditions concerning the project. Submit notification of conflict in ample time to prevent unwarranted changes in any work. Review other Divisions of these specifications to determine their requirements.
- B. Because of the complicated relationship of this work to the total project, conscientiously study the relation and cooperate as necessary to accomplish the full intent of the documents.
- C. Provide sleeves and inserts in forms as required for the work. Stub up and protect open

ends of pipe before any concrete is placed. Furnish sizes of required equipment pads. Furnish and locate bolts and fittings required to be cast in them.

- D. Locate and size openings required for installation of work specified in this Division in sufficient time to prevent delay in the work.
- E. Refer to other Divisions of the specifications for the scope of required connections to equipment furnished under that Division. Determine from the Contractor for the various trades, the Owner, and by direction from the Architect/Engineer, the exact location of all items.

1.9 CONCEALED AND EXPOSED WORK

- A. When the word "concealed" is used in connection with insulating, painting, piping, ducts and the like, the work is understood to mean hidden from sight as in chases, furred spaces or above ceilings. "Exposed" is understood to mean open to view.

1.10 GUARANTEE

- A. Guarantee work for 1 year from the date of substantial completion of the project. During that period make good any faults or imperfections that may arise due to defects or omissions in material, equipment or workmanship. At the Owner's option, replacement of failed parts or equipment shall be provided.

1.11 MATERIAL AND EQUIPMENT

- A. Furnish new and unused materials and equipment meeting the requirements of the paragraph specifying acceptable manufacturers. Where two or more units of the same type or class of equipment are required, provide units of a single manufacturer.

1.12 NOISE AND VIBRATION

- A. Select equipment to operate with minimum noise and vibration. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, rectify such conditions at no additional cost. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate at no additional cost that equipment performs within designated limits on a vibration chart.

1.13 ACCEPTABLE MANUFACTURERS

- A. Manufacturers names and catalog number specified under sections of Division 23 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, equal to that specified, manufactured by a named manufacturer will be acceptable on approval. A request for prior approval of equipment not listed must be submitted ten (10) days before bid due date. Submit complete design and performance data to the Engineer.

1.14 OPERATING TESTS

- A. After all mechanical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequencing and operation throughout the range of operation. Tests shall be made in the presence of the Architect/Engineer. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual sections. Submit 3 copies of all certifications and test reports adequately in advance of completion

of the work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.

1.15 WARRANTIES

- A. Submit 3 copies of all warranties and guarantees for systems, equipment, devices and materials. These shall be included in the Operating and Maintenance Manuals.

1.16 BUILDING CONSTRUCTION

- A. It shall be the responsibility of each sub-contractor to consult the Architectural and Engineering drawings, details, and specifications and thoroughly familiarize himself with the project and all job related requirements. Each sub-contractor shall cooperate with the General Contractor to verify that all piping and other items are placed in the walls, furred spaces, chases, etc., so there will be no delays in the job.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 OPENINGS

- A. Framed, cast or masonry openings for ductwork, equipment or piping are specified under other divisions. Drawings and layout work for exact size and location of all openings are included under this division.

3.2 AIR FILTERS AND PIPE STRAINERS

- A. Immediately prior to substantial completion of the project, inspect, clean and service air filters and strainers. Replace air filters.

3.3 LUBRICATION, REFRIGERANT AND OIL

- A. Provide a complete charge of correct lubricant for each item of equipment requiring lubrication.
- B. Provide a complete and working charge of proper refrigerant, free of contaminants, into each refrigerant system. After each system has been in operation long enough to ensure completely balanced conditions, check the charge and modify for proper operation as required.
- C. Provide a complete charge of special oil for refrigeration use, suitable for operation with refrigerant, in each system.

3.4 HOUSEKEEPING PADS

- A. Provide equipment housekeeping pads under all floor mounted and ground mounted HVAC equipment, and as shown on the drawings.
- B. Concrete work as specified in Division 3.
- C. Concrete pads:
 - 1. 4" high, rounded edges, minimum 2500 psi unless otherwise indicated on the drawings

2. Chamfer strips at edges and corner of forms.
3. Smooth steel trowel finish.
4. Doweled to existing slab

D. Install concrete curbs around duct penetrations or multiple pipe penetrations.

3.5 INSTRUCTION OF OWNER'S PERSONNEL

- A. Prior to final inspection, conduct an on-site training program to instruct the Owner's operating personnel in the operation and maintenance of the mechanical systems.
 1. Provide the training during the Owner's regular working day.
 2. The Instructors shall each be experienced in their phase of operation and maintenance of building mechanical systems and with the project.
- B. Time to be allocated for instructions.
 1. Minimum of 8 hours dedicated instructor time.
- C. Before proceeding with the on-site training program, submit the program syllabus; proposed time and dates; and other pertinent information for review and approval.
 1. One copy to the Owner.
 2. One copy to the Architect/Engineer.
- D. The Owner will provide a list of personnel to receive instructions, and will coordinate their attendance at the agreed upon times.
- E. Use the operation and maintenance manuals as the basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut down of each item of equipment.
- G. Demonstrate equipment functions (both individually and as part of the total integrated system).
- H. Prepare and insert additional data in the operating and maintenance manuals when the need for additional data becomes apparent during instructions.
- I. Submit a report within one week after completion of the training program that instructions have been satisfactorily completed. Give time and date of each demonstration and hours devoted to the demonstration, with a list of people present.
- J. At the conclusion of the on-site training program, have the person designated by the Owner sign a certificate to certify that he/she has a proper understanding of the system, that the demonstrations and instructions have been satisfactorily completed, and the scope and content of the operating and maintenance manuals used for the training program are satisfactory.
- K. Provide a copy of the report and the certificate in an appropriately tabbed section of each Operating and Maintenance Manual.

3.6 EQUIPMENT IDENTIFICATION

- A. Provide a laminated engraved plastic nameplate on each piece of equipment and starter.
 1. Designation approved by Architect/Engineer.

2. Equipment includes, but is not limited to, air handling units, fan coil units, variable volume boxes, fans, pumps, boilers and chillers.
3. Submit schedule of equipment to be included and designations.

B. Provide nameplates with 1/2" high letters and fastened with epoxy or screws.

3.7 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and subsurface obstructions which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
1. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided.
 2. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- B. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

3.8 PROTECTION

- A. Protect work, equipment, fixtures, and materials. At work completion, work must be clean and in original manufacturer's condition.

3.9 INDOOR AIR QUALITY

- A. All equipment and ductwork shall be installed to allow sufficient space for testing, maintenance, and commissioning functions. Access doors or panels shall be installed in ventilation equipment, ductwork, and plenum enclosures for inspection and cleaning of outdoor air intakes, mixing plenums, up and downstream of coils, filters, drain pans and fans.
- B. Practice source control and eliminate potential contaminants in material selection, installation, and maintenance.
- C. Provide installation and disposal instructions for all materials and chemicals that are potential contaminants.
- D. Obtain and conform to the requirements of the Material Safety Data Sheets (MSDSs) in the use of materials.
- E. Utilize manufacturer's recommendations and provide installation instructions for all chemicals, compounds, and potential contaminants including pre-installation degassing if required.
- F. Ventilate completed building prior to final completion using no less than design outside air for at least 48 hours before occupancy.
- G. Make provisions for controls to prevent the entry of air contaminants into the HVAC air distribution system.
- H. Steps shall be taken to ensure that the HVAC system continues to function effectively and

Lake Tawakoni Tournament Facility - Restroom, Hardscape,
and Landscape
VAN ZANDT COUNTY, TEXAS
STUDIO RED PROJECT NO. 2002

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are not damaged or contaminated during construction activities.

END OF SECTION 23 0500

SECTION 23 0510 - HVAC CONTRACT QUALITY CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Contract quality control including workmanship, manufacturer's instructions, mock-ups and demonstrations.

1.2 QUALITY CONTROL PROGRAM

- A. Maintain quality control over supervision, subcontractors, suppliers, manufacturers, products, services, site conditions and workmanship to produce work in accordance with contract documents.

1.3 WORKMANSHIP

- A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
- B. Perform work by persons qualified to produce workmanship of specified quality.
- C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking. Under no conditions shall material or equipment be suspended from structural bridging.
- D. Provide finishes to match approved samples. All exposed finishes shall be approved by the Architect. Submit color samples as required.

1.4 MANUFACTURER'S INSTRUCTIONS

- A. Comply with instructions in full detail, including each step in sequence.
- B. Should instruction conflict with Contract Documents, request clarification from Architect / Engineer before proceeding.

1.5 MANUFACTURER'S CERTIFICATES

- A. When required in individual Specification Sections, submit manufacturer's certificate in duplicate, certifying that products meet or exceed specified requirements.

1.6 MANUFACTURER'S FIELD SERVICES

- A. When required in individual Specification Sections, manufacturer shall provide qualified personnel to observe:
 - 1. Field conditions.
 - 2. Condition of installation.
 - 3. Quality of workmanship.
 - 4. Start-up of equipment.
 - 5. Testing, adjusting, and balancing of equipment.
- B. Representative shall make written report of observations and recommendations to Architect / Engineer.

PART 2 - PRODUCTS

SALAS O'BRIEN

HVAC CONTRACT QUALITY CONTROL

23 0510-1

Salas O'Brien Registration #F-4111

2.1 REFERENCE APPLICABLE SPECIFICATION SECTIONS.

PART 3 - EXECUTION

3.1 PROTECTION OF EQUIPMENT

- A. Do not deliver equipment to the project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather will be rejected, and the Contractor is obligated to furnish new equipment of a like kind at no additional cost to the Owner.
- B. Adequately protect equipment from damage after delivery to the project. Cover with heavy tarpaulins, drop cloths or other protective coverings as required to protect from plaster, paint, mortar and/or dirt. Do not cover with plastic materials and trap condensate and cause corrosion.

END OF SECTION 23 0510

SECTION 23 0512 - SHOP DRAWINGS, COORDINATION DRAWINGS & PRODUCT DATA

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Prepare submittals as required by these specifications as outlined below.
- B. The term submittal, as used herein, refers to all:
 - 1. Shop Drawings
 - 2. Coordination Drawings
 - 3. Product data
- C. Submittals shall be prepared and produced for:
 - 1. Distribution as specified
 - 2. Inclusion in the Operating and Maintenance Manual, as specified, in the related section

1.2 SHOP DRAWINGS

- A. Present drawings in a clear and thorough manner. Identify details by reference to sheet and detail, schedule, or room numbers shown on Contract Drawings.
- B. Show all dimensions of each item of equipment on a single composite Shop Drawing. Do not submit a series of drawings of components.
- C. Identify field dimensions; show relationship to adjacent features, critical features, work, or products.
- D. Submit shop drawings in plan, elevation and sections, showing equipment in mechanical equipment areas.

1.3 COORDINATION DRAWINGS

- A. Present in a clear and thorough manner. Title each drawing with project name. Identify each element of drawings by reference to sheet number and detail, or room number of contract documents. Minimum drawing scale: $\frac{1}{4}'' = 1'-0''$.
- B. Prepare coordination drawings to coordinate installations for efficient use of available space, for proper sequence of installation, and to resolve conflicts. Coordinate with work specified in other sections and other divisions of the specifications.
- C. For each mechanical room and for each outside equipment pad where equipment is located, submit plan and elevation drawings. Show:
 - 1. Actual mechanical equipment and components to be furnished
 - 2. Service clearance
 - 3. Relationship to other equipment and components
 - 4. Roof drains and leader piping
 - 5. Fire protection piping and equipment
- D. Identify field dimensions. Show relation to adjacent or critical features of work or products.
- E. Related requirements:
 - 1. Ductwork shop drawings
 - 2. Coordination drawing specified in Division 26

- F. Submit shop drawings in plan, elevation and sections, showing equipment in mechanical equipment areas.
- G. Gas piping sketch indicating proposed location of piping prior to proceeding with the installation.

1.4 PRODUCT DATA AND INSTALLATION INSTRUCTION

- A. Submit only pages which are pertinent to the project. All options which are indicated on the product data shall become part of the contract and shall be required whether specified are not.
- B. Mark each copy of standard printed data to identify pertinent products, referenced to specification section and article number.
- C. Show reference standards, performance characteristics and capacities; wiring and piping diagrams and controls; component parts; finishes; dimensions and required clearances.
- D. Modify manufacturer's standard schematic drawings and diagrams to supplement standard information and to provide information specifically applicable to the work. Delete information not applicable.
- E. Mark up a copy of the specifications for the product. Indicate in the margin of each paragraph the following: COMPLY, DO NOT COMPLY, or NOT APPLICABLE. Explain all DO NOT COMPLY statements.
- F. Provide a separate transmittal for each submittal item. Transmittals shall indicate product by specification section name and number. Separate all submittals into appropriate specification section number. Do not combine specification sections.

1.5 MANUFACTURERS INSTRUCTIONS

- A. Submit Manufacturer's instructions for storage, preparation, assembly, installation, start-up, adjusting, calibrating, balancing and finishing.

1.6 CONTRACTOR RESPONSIBILITIES

- A. Review submittals prior to transmittal.
- B. Determine and verify:
 - 1. Field measurements
 - 2. Field construction criteria
 - 3. Manufacturer's catalog numbers
 - 4. Conformance with requirements of Contract Documents
- C. Coordinate submittals with requirements of the work and of the Contract Documents.
- D. Notify the Architect/Engineer in writing at time of submission of any deviations in the submittals from requirements of the Contract Documents.
- E. Do not fabricate products, or begin work for which submittals are specified, until such submittals have been produced and bear contractor's stamp. Do not fabricate products or begin work scheduled to have submittals reviewed until return of reviewed submittals with Architect / Engineer's acceptance.

- F. Contractor's responsibility for errors and omissions in submittals is not relieved whether Architect / Engineer reviews submittals or not.
- G. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved whether Architect/Engineer reviews submittals or not, unless Architect / Engineer gives written acceptance of the specific deviations on reviewed documents.
- H. Submittals shall show sufficient data to indicate complete compliance with Contract Documents:
 - 1. Proper sizes and capacities
 - 2. That the item will fit in the available space in a manner that will allow proper service
 - 3. Construction methods, materials and finishes
- I. Schedule submissions at least 15 days before date reviewed submittals will be needed.

1.7 SUBMISSION REQUIREMENTS

- A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Project or in the work of any other Contractor.
- B. Number of submittals required:
 - 1. Shop Drawings and Coordination Drawings: Submit one reproducible transparency and three opaque reproductions.
 - 2. Product Data: Submit the number of copies which the contractor requires, plus those which will be retained by the Architect/Engineer.
- C. Accompany submittals with transmittal letter, in duplicate, containing:
 - 1. Date
 - 2. Project title and number
 - 3. Contractor's name, address and contact number.
 - 4. The number of each Shop Drawing, Project Datum and Sample submitted
 - 5. Other pertinent data
- D. Submittals shall include:
 - 1. The date of submission
 - 2. The project title and number
 - 3. Contract Identification
 - 4. The names of:
 - a. Contractor
 - b. Subcontractor
 - c. Supplier
 - d. Manufacturer
 - 5. Identification of the product
 - 6. Field dimensions, clearly identified as such
 - 7. Relation to adjacent or critical features of the work or materials
 - 8. Applicable standards, such as ASTM or federal specifications numbers
 - 9. Identification of deviations from contract documents
 - 10. Suitable blank space for General Contractor and Architect/Engineer stamps
 - 11. Contractor's signed and dated Stamp of Approval
- E. Coordinate submittals into logical groupings to facilitate interrelation of the several items:
 - 1. Finishes which involve Architect/Engineer selection of colors, textures or patterns

2. Associated items which require correlation for efficient function or for installation

1.8 SUBMITTAL SPECIFICATION INFORMATION

- A. Every submittal document shall bear the following information as used in the project manual:
 1. The related specification section number
 2. The exact specification section title
- B. Submittals delivered to the Architect/Engineer without the specified information will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

1.9 RESUBMISSION REQUIREMENTS

- A. Make re-submittals under procedures specified for initial submittals.
 1. Indicate that the document or sample is a re-submittal
 2. Identify changes made since previous submittals
- B. Indicate any changes which have been made, other than those requested by the Architect / Engineer.

1.10 CONTRACTOR'S STAMP OF APPROVAL

- A. Contractor shall stamp and sign each document certifying to the review of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.
- B. Contractor's stamp of approval on any submittal shall constitute a representation to Owner and Architect/Engineer that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that Contractor has reviewed or coordinated each submittal with the requirements of the work and the Contract Documents.
- C. Do not deliver any submittals to the Architect/Engineer that do not bear the Contractor's stamp of approval and signature.
- D. Submittals delivered to the Architect/Engineer without Contractor's stamp of approval and signature will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

1.11 ARCHITECT / ENGINEER REVIEW OF IDENTIFIED SUBMITTALS

- A. The Architect / Engineer will:
 1. Review identified submittals with reasonable promptness and in accordance with schedule
 2. Affix stamp and initials or signature, and indicate requirements for re-submittal or approval of submittal
 3. Return submittals to Contractor for distribution or for resubmission
- B. Review and approval of submittals will not extend to design data reflected in submittals which is peculiarly within the special expertise of the Contractor or any party dealing directly with the Contractor.

- C. Architect / Engineer's review and approval is only for conformance with the design concept of the project and for compliance with the information given in the contract.
 - 1. The review shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto.
 - 2. The review shall not extend to review of quantities, dimensions, weights or gauges, fabrication processes or coordination with the work of other trades.
- D. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

1.12 SUBSTITUTIONS

- A. Do not make requests for substitution employing the procedures of this Section.
- B. The procedure for making a formal request for substitution is specified in Div. 1.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION 23 0512

SECTION 23 0513 - ELECTRICAL PROVISIONS OF HVAC WORK

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electrical provisions to be provided as mechanical work are indicated in other Division 23 sections, on drawings, and as specified.
- B. Types of work, normally recognized as electrical but provided as mechanical, specified or partially specified in this Section, include but are not necessarily limited to the following:
 - 1. Motors for mechanical equipment.
 - 2. Starters for motors of mechanical equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 3. Wiring from motors to disconnect switches or junction boxes for motors of mechanical equipment, but only where specifically indicated to be furnished integrally with equipment.
 - 4. Wiring of field-mounted float control switches, flow control switches, and similar mechanical-electrical devices provided for mechanical systems, to equipment control panels.
 - 5. Wiring of smoke detectors for shutdown of air handling equipment when a fire alarm system is not included in the project.
 - 6. Wiring of oil pump, vibration and oil level limit switches for cooling towers.
 - 7. Refrigerant monitor/sensor/alarming and field installed visual/audible display alarms.
 - 8. Pipe heat tracing.
 - 9. Cooling tower vibration switch/interlock/reset.
 - 10. Field interlock wiring from chiller: flow switches, pump aux. Contacts, pump start/stop.
 - 11. Power supply 120 VAC and control signal from chiller control panel to condenser water flow control valve installed in piping leaving chiller.
 - 12. Wiring of all related circulating water system chemical treatment devices.
 - a. Low voltage electric contacting water meter
 - b. Solenoid valve/blow-down assembly
 - 13. Radiant heater timer switches and/or thermostats
 - 14. Low Voltage thermostat wiring
- C. Refer to Division 23 Controls Sections for related control system wiring.
- D. Refer to Division 23 sections for specific individual mechanical equipment electrical requirements.
- E. Refer to Division 26 sections for motor starters and controls not furnished integrally with mechanical equipment.
- F. Refer to Division 26 sections for junction boxes and disconnect switches required for motors and other electrical units of mechanical equipment.

1.2 RELATED WORK

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Sections, apply to work of this Section.

1.3 QUALITY ASSURANCE

- A. Wherever possible, match elements of electrical provisions of mechanical work with similar elements of electrical work specified in Division 26 sections for electrical work not otherwise specified.
- B. For electrical equipment and products, comply with applicable NEMA standards, and refer to NEMA standards for definitions of terminology. Comply with National Electrical Code (NFPA 70) for workmanship and installation requirements.

1.4 SUBMITTALS

- A. Include in listing of motors, voltage, notation of whether motor starter is furnished or installed integrally with motor or equipment containing motors.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Provide motors for mechanical equipment manufactured by one of the following:
 - 1. Baldor Electric Company.
 - 2. Century Electric Div., Inc.
 - 3. General Electric Co.
 - 4. Louis Allis Div.; Litton Industrial Products, Inc.
 - 5. Lincoln Electric
 - 6. Marathon Electric Mfg. Corp.
 - 7. Reliance Electric Co.
 - 8. Westinghouse Electric Corp.
 - 9. WEG
- B. Motor Characteristics. Except where more stringent requirements are indicated, and except where required items of mechanical equipment cannot be obtained with fully complying motors, comply with the following requirements for motors of mechanical work:
- C. Temperature Rating. Rated for 40 Degrees C environment with maximum 50 Degrees C temperature rise for continuous duty at full load (Class A Insulation).
- D. Provide each motor capable of making starts as frequently as indicated by automatic control system, and not less than 5 starts per hour for manually controlled motors.
- E. Phases and Current Characteristics. Provide squirrel-cage induction polyphase motors for 3/4hp and larger, and provide capacitor-start single-phase motors for 1/2hp and smaller, except 1/6hp and smaller may, at equipment manufacturer's option, be split-phase type. Coordinate current characteristics with power specified in Division 26 sections, and with individual equipment requirements specified in other Division 23 requirements. For 2-speed motors provide 2 separate windings on polyphase motors. Do not purchase motors until power characteristics available at locations of motors have been confirmed, and until rotation directions have been confirmed.
- F. Service Factor. 1.15 for polyphase motors and 1.35 for single-phase motors.
- G. Motor Construction. Provide general purpose, continuous duty motors, Design "B" except "C" where required for high starting torque.
 - 1. Frames. NEMA #56.

2. Bearings are to be ball or roller bearings with inner and outer shaft seals, regreasable except permanently sealed where motor is inaccessible for regular maintenance. Where belt drives and other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Refer to individual section of Division 23 for fractional-hp light-duty motors where sleeve-type bearings are permitted.
3. Except as indicated, provide open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation, and provide guarded drip-proof motors where exposed to contact by employees or building occupants. Provide weather-protected Type I for outdoor use, Type II where not housed. Refer to individual sections of Division 23 for other enclosure requirements.
4. Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.
5. Noise Rating: Provide "Quiet" rating on motors.

H. All motors shall be premium efficiency.

I. Provide an inverter duty motor on all equipment that utilizes a variable frequency drive.

2.2 EQUIPMENT FABRICATION

- A. Fabricate mechanical equipment for secure mounting of motors and other electrical items included in work. Provide either permanent alignment of motors with equipment, or adjustable mountings as applicable for belt drives, gear drives, special couplings and similar indirect coupling of equipment. Provide safe, secure, durable, and removable guards for motor drives. Arrange for lubrication and similar running-maintenance without removal of guards.

2.3 GENERAL REQUIREMENTS – SHAFT GROUNDING RINGS

- A. All motors operated on variable frequency drives shall be equipped with a maintenance-free, conductive microfiber shaft grounding ring to meet NEMA MG-1, 3.4.4.4.3 requirements, with a minimum of two rows of circumferential microfibers to discharge damaging shaft voltages away from the bearings to ground. SGR's Service Life: Designed to last for service life of motor. Provide AEGIS SGR Conductive MicroFiber Shaft Grounding Ring, or approved equal.
- B. Application Note: Motors up to 100 HP shall be provided with one shaft ground ring installed on either the drive end or non-drive end. Motors over 100 HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor with the exception of line contact bearings in the drive end of the machine. In this instance the line contact bearing must be electrically insulated and the AEGIS Bearing Protection Ring installed on the opposite drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and

Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

- B. Verify voltage with Electrical Plans.

END OF SECTION 23 0513

SECTION 23 0517 - HVAC ACCESS DOORS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install access doors in wall or ceiling locations as required or shown for access to valves, controls, fire dampers, air distribution devices and other equipment requiring maintenance, adjustment or operation.

PART 2 - PRODUCTS

2.1 NON-FIRE RATED ACCESS DOORS

- A. 16-Gauge frames
- B. 14-gauge steel panels
- C. Continuous fully concealed hinges
- D. Flush screwdriver cam lock & cylinder lock for Owner selection
- E. Automatic closing and latching mechanism
- F. Prime coat finish
- G. Brushed satin stainless steel finish for restroom, kitchen or cafeteria installation
- H. Material suitable for wall and/or ceiling mounting

2.2 FIRE RATED ACCESS DOORS

- A. UL listed, 1-1/2 hour Label "B", access doors
- B. 16-Gauge stainless steel
- C. 20-Gauge insulated sandwich-type door panel.
- D. Two inch thick with fire rated insulation
- E. Continuous fully concealed hinge
- F. Automatic closing and latching mechanism
- G. Knurled knob and recessed key operation for Owner selection
- H. Interior latch release slide for opening from inside
- I. Prime coat finish
- J. Material suitable for wall and/or ceiling mounting

2.3 ACCEPTABLE MANUFACTURERS

- A. Milcor
- B. MIFAB
- C. Acudor
- D. Elmdor

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Access doors specified in Division 23 will be installed by other crafts. Not all required access doors are shown. Coordinate with the Contractor to locate access doors for ease of operation and maintenance of concealed equipment.
- B. Installation shall be in accordance with the manufacturer's printed instructions.
- C. Minimum size required:
 - 1. 36" x 24" for Mechanical HVAC equipment related items
 - 2. 18" x 18" for electrical related items

END OF SECTION 23 0517

SECTION 23 3113 - DUCTWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Duct construction, support and accessories. Dimensions shown on the drawings are free area dimensions.

1.2 RELATED WORK

- A. Division 23 Mechanical
 - 1. Air Devices
 - 2. Fans
 - 3. Testing, Balancing and Adjusting (TAB) of Environmental Systems
- B. Division 9 – Finishes, Painting and Color Coding

1.3 QUALITY ASSURANCE

- A. The intent of ductwork specifications is to obtain superior quality workmanship resulting in an installation that is absolutely satisfactory in both function and appearance. Provide ductwork in accordance with the specifications for each type of service.
- B. An approved contractor for this work under this division shall be:
 - 1. A specialist in this field and have the personnel, experience, training, skill, and the organization to provide a practical working system.
 - 2. Able to furnish evidence of having contracted for and installed not less than 5 systems of comparable size and type that have served their owners satisfactorily for not less than 5 years.

1.4 GUARANTEE

- A. Guarantee ductwork for 1 year from the date of substantial completion. The guarantee covers workmanship, noise, chatter, whistling, or vibration. Ductwork shall be free from pulsation under conditions of operation.

1.5 CONTRACTOR COORDINATION

- A. Erect ducts in the general locations shown, but conform to structural and finish conditions of the building. Before fabricating any ductwork, check the physical conditions at the job site and make necessary changes in cross sections, offsets, and similar items, whether they are specifically indicated or not.
- B. Coordinate location of ductwork with structural members and Architectural drawings and requirements.

1.6 SHOP DRAWINGS AND SAMPLES

- A. Submit shop drawings of all ductwork layouts, including enlarged plans and elevations of all air handling equipment, and submit details of duct fittings, including particulars such as gauge sizes, welds, and configurations prior to starting work.
- B. Submit product data and sealing materials to be used.

- C. Submit sound attenuation data.
- D. Submit shop drawings in plan, elevation and sections, and three-dimensional view showing equipment in mechanical equipment areas.

PART 2 - PRODUCTS

2.1 STANDARDS AND CODES

- A. Except as otherwise indicated, sheet metal ductwork material and installation shall comply with the latest edition of SMACNA HVAC Duct Construction Standards. Air distribution devices (such as dampers) included in this specification shall comply with the latest applicable SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems and NFPA 90A.

2.2 DUCT MATERIAL AND CONSTRUCTION

- A. Except for the special ducts specified below use lock forming quality prime galvanized steel sheets or coils up to 60" wide. Stencil each sheet with gauge and manufacturer's name. Stencil coils of sheet steel throughout on 10' centers with gauge and manufacturer's name. Provide certification of duct gauge and manufacturer for each size duct.
- B. Rectangular low and medium pressure duct constructed of sheet metal in accordance with the latest edition of SMACNA HVAC Duct Construction Standards.
- C. Medium pressure oval and round ductwork shall be spiral seam. Spiral lock-seam SMACNA Type RL-1. Fittings shall be welded construction.
 - 1. Galvanized
- D. Low pressure round ducts shall be shop fabricated with snap lock longitudinal seams. Ducts shall be constructed for a minimum of 2" w.g. static pressure.
- E. Dishwasher Hood Exhaust System: Welded 304 Stainless steel.
- F. Shower Area Exhaust Systems: Welded 304 Stainless steel.
- G. Kitchen exhaust duct: Welded Black steel, minimum 16 gauge
- H. Natatorium Ductwork: 304 Stainless Steel

2.3 ACOUSTICAL DUCT

- A. Duct and fittings:
 - 1. Double wall acoustically treated.
 - 2. Annular space packed with fiberglass insulation.
 - 3. Perforated metal liner to provide specific acoustic impedance
 - 4. Insulation 1.0 pcf. 1 inch thick
 - 5. United McGill Acousti-K27 spiral lockseam or approved equal
 - 6. Material as indicated below:
 - a. Paintable Galvanized Steel
- B. Pressure rating and tests as specified for single wall ductwork.

2.4 DUCT SEALING OF SEAMS AND JOINTS

- A. Follow seal classification as indicated in Table 1-2 of SMACNA "HVAC AIR DUCT LEAKAGE TEST MANUAL". Use seal class A for 4" w.g. static. All longitudinal and transverse joints and seams shall be sealed by use of a fireproof, non-hardening, and non-migrating elastomeric sealant. With the exception of continuously welded joints and machine made spiral lock seams, joints and seams made air tight with duct sealer.
1. Indoor applications – Foster 32-14
 2. Outdoor applications – Foster 32-17

2.5 FLEXIBLE DUCT LOW PRESSURE

- A. Construction:
1. Continuous galvanized spring steel wire helix, with reinforced metalized cover
 - a. The fabric shall be mechanically fastened to the steel helix without the use of adhesives.
 2. UL 181 Class I air duct label
 3. Reinforced vapor barrier jacket
 4. Rated for use at system pressure (6" wc minimum)
 5. Flexible duct connections from lateral taps to variable volume boxes or terminal boxes shall be rated at twice the maximum pressure rating of the medium pressure system.
- B. Fire hazard classification:
1. Flame spread rating 25 maximum.
 2. Smoke developed rating 50 maximum.
- C. Thermal characteristics:
1. R-6 BTU/hr/sq. ft./°F (when located in a conditioned plenum)
 2. R-8 BTU/HR/Sq.Ft./°F (when located in an unconditioned plenum)
 3. 2" minimum wall thickness insulation with 1" overlap
- D. Acceptable manufacturers:
1. Flexmaster
 2. Hart & Cooley
 3. Omniair
 4. Peppertree Air Solutions

2.6 FLEXIBLE DUCT MEDIUM/HIGH PRESSURE

- A. The duct shall be constructed of a heavy coated fiberglass cloth fabric supported by helical wound galvanized steel. The fabric shall be mechanically fastened to the steel helix without the use of adhesives.
- B. The internal working pressure rating shall be at least as follows with a bursting pressure of at least two times the working pressure:
Positive: 12" w.g.
Negative: 5" w.g.
- C. The duct shall be rated for a velocity of at least 5500 fpm.
- D. Suitable for operating temperature range of -20°F to +250°F.

- E. Factory insulate the flexible duct with fiberglass insulation.
 - 1. R-6 BTU/hr/sq. ft./°F (when located in a conditioned plenum)
 - 2. R-8 BTU/HR/Sq.Ft./°F (when located in an unconditioned plenum)
 - 3. 2" minimum wall thickness insulation with 1" overlap
- F. Cover the insulation with a fire retarding polyethylene vapor barrier jacket having a permeance of not greater than 0.10 perms when tested in accordance with ASTM E96, Procedure A.
- G. Acceptable manufacturers:
 - 1. Flexmaster
 - 2. Omniair
 - 3. Peppertree Air Solutions

2.7 FIRE DAMPERS

- A. Fire dampers for required wall ratings that are 95% minimum free area. Provide Type B or Type C UL dampers for low, medium and high-pressure rectangular, square or round ducts. Dampers shall be activated by a fusible link designed to react at 165°F. Install per manufactures recommendations to provide a UL assembly. Provide sealed sleeve to meet desired leakage performance.
- B. Acceptable Manufacturers:
 - 1. Ruskin
 - 2. Prefco Products
 - 3. Air Balance
 - 4. Greenheck, Inc.
 - 5. Nailor Industries
 - 6. Pottoroff

2.8 CEILING RADIATION DAMPERS

- A. Ceiling Radiation Dampers at location shown on plans constructed and tested in accordance with the current edition of UL555C of a minimum 22 gauge (0.8) blades, hinged in the center and held open with a 165° fusible link. Maximum blade height in the open position shall be 10" overall regardless of damper area. Maximum distance between blades held in the open position shall be 1-1/4" for units not requiring blade insulation and 1/4" for units with sheetrock blade insulation. Blades requiring radiation protection insulation shall utilize sheetrock. Refractory Ceramic or Mineral Wool Fiber is not allowed in the air stream. Radiation insulation outside of the air stream shall be Mineral Wool Fiber only. Ceramic Fiber Material is not approved for use. Units shall be constructed of a minimum 20-gauge (0.9) frame welded at all seams.
- B. Acceptable Manufactures
 - 1. Ruskin
 - 2. Prefco
 - 3. Air Balance
 - 4. Phillips
 - 5. Safe-Air
 - 6. Nailor Industries

2.9 WALL LOUVERS

- A. Refer to schedule on drawings. Coordinate with Architectural Drawings.

- B. All louver frames shall be a minimum of 0.08" extruded aluminum. All blades shall be a minimum of 0.081" extruded aluminum. Beginning point of water penetration at 0.01 oz/sq.ft. Shall be a minimum of 800 ft/min.
- C. Provide all louvers with removable aluminum bird screen with 1/4" mesh.
- D. Louvers shall be AMCA-550 tested and approved.
- E. Acceptable manufacturers:
 - 1. American Warming and Ventilation
 - 2. Arrow
 - 3. Greenheck
 - 4. NCA
 - 5. Pottorff
 - 6. Ruskin

2.10 CONTROL DAMPERS

- A. Opposed blade dampers for 2-position and modulating control. Construct frames of 13-gauge galvanized sheet metal with provisions for duct mounting. Damper blades not exceeding 8" in width, of corrugated-type construction, fabricated from two sheets of 22-gauge galvanized sheet metal spot-welded together or a single 16-gauge sheet. Make bearings of nylon or oil-impregnated, sintered bronze. Make shafts of 1/2" zinc-plated steel. Blades suitable for high velocity performance. Construct damper so that leakage does not exceed 1/2% based on 2000 fpm and 4" static pressure. Provide replaceable resilient seals along top, bottom and sides of frame and along blade edge. Submit leakage and flow characteristics data with shop drawings. Linkage shall be concealed out of the air stream within damper frame to reduce pressure drop and noise.
- B. Acceptable Model is Ruskin Model CD60.

2.11 VOLUME DAMPERS

- A. Manual balancing dampers that meet or exceed the following minimum construction standards:
 - 1. Frame 16-gauge
 - 2. Blades 16-gauge
 - 3. Bearings corrosion resistant
 - 4. Concealed linkage
 - 5. Opposed blade dampers
- B. Acceptable manufacturer:
 - 1. Ruskin Model MD-35 or approved equal, by
 - 2. Arrow
 - 3. American Warming and Ventilating
 - 4. Nailor Industries
 - 5. Pottorff

2.12 ACCESS DOORS

- A. Round spin-in door of galvanized steel.
 - 1. Fire proof sealing gaskets and quick fastening locking devices
 - 2. Insulated door

3. Conform to the requirements of the NFPA
 4. Identification and use of each access door
 5. UL label to match the construction in which it is installed
 6. Cable attached to door and outer frame
 7. Low leakage Access Door
- B. Acceptable Manufacturer
1. Flex master, Inspector Series
 2. Approved Equal

2.13 DIFFUSER FITTINGS LOW PRESSURE TAPS

- A. Fitting shall meet or exceed the following minimum construction standards:
1. Conical with a base diameter two inches larger than the tap diameter.
 2. Construct fitting and damper of galvanized steel in accordance with ASTM A 527, G90 finish.
 - a. Fitting with a 3/16-inch high stop bead approximately 2-1/2-inches from the discharge end of the fitting
 - b. Provide the fitting with a butterfly damper, damper rod, end bearings and heavy duty locking quadrant.
 - c. Size the length of the straight section of the fitting to match the damper blade diameter. Center the damper blade in the straight section.
 3. Match the fitting body gauge to the SMACNA duct gauge, but not less than:
 - a. Through 8 inches: 26 gauge; Damper blade 22 gauge
 - b. 10 inches and 12 inches: 24 gauge; Damper blade 22 gauge
 - c. 14 inches and 16 inches: 22 gauge; Damper blade 22 gauge
 - d. 18 inches and 20 inches: 20 gauge; Damper blade 20 gauge
 4. Fasten damper blade to a 3/8 X 3/8 continuous square rod with minimum (2) galvanized U-bolts.
 5. Support the damper rod to the fitting with airtight nylon end bushings / bearings.
 6. Provide the damper with a self-locking regulator and handle.
 7. Provide a 2" sheet metal stand-off to extend the regulator.
 8. Flex duct grip area – 2 inches behind retaining bead
 9. Flex duct retaining bead – 1 inch from end
 10. Conical length of at least 3 inches
 11. Barrel length of at least 9 inches

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use construction methods and requirements as outlined in SMACNA HVAC Duct Construction Standards as well as SMACNA Balancing and Adjusting publications, unless indicated otherwise in the specifications. Refer to details on the drawings for additional information.
- B. Reinforce ducts in accordance with recommended construction practice of SMACNA. Provide additional reinforcement of large plenums as required to prevent excessive flexing and or vibration.
- C. Cross break or bead sheet metal for rigidity, except ducts that are 12" or less in the longest dimension.
- D. Where ducts pass through walls in exposed areas, install suitable escutcheons made of

sheet metal angles as closers.

- E. At locations where ductwork passes through floors, provide watertight concrete curb around penetration.
- F. Support ducts where passing through floors with galvanized steel structural angles of adequate bearing surface.
- G. Metal or lined ductwork exposed to view through grilles, registers, and other openings shall be painted flat black. Do not install grilles, registers, or similar items until painting is complete.
- H. Fire Dampers shall be installed per manufacturer's recommendations to create a UL rated assembly.
- I. Install end bearing at all location where damper shaft penetrates duct wall.
- J. Clean duct to remove accumulated dust. Ducts shall be closed on ends between phases of fabrication to assure that no foreign material enters the ducts.

3.2 DUCTWORK

- A. Construct rectangular ducts and round ducts in accordance with the latest SMACNA HVAC Duct Construction Standards. Use the static pressure specified on the air handling unit schedule or fan schedules as a minimum for duct construction. All ductwork between the variable volume air handling units and the terminal units shall be constructed to the medium pressure ductwork specification.
- B. Provide adjustable, galvanized splitter-dampers, pivoted at the downstream end with appropriate control device at each supply duct split.
- C. For branch ducts wider than 18", and when shown on drawings provide extractors with an appropriate control device at each rectangular zone or branch supply duct connection. Provide controllers for extractors. Branch ducts shall have a 45° angle in the direction of flow. Do not provide extractor at branch ducts to sidewall registers where the registers are within 10 feet of the main duct.
- D. Shop manufactured curved blade scoops may be used for branch duct takeoffs up to 18" wide. Taper scoop blade to the end, to prevent any sagging that may cut into, or damage duct liner if specified during operation.
 - 1. Construct shop manufactured scoops and splitter blades of galvanized sheet metal 2 full gauges heavier than equivalent sheet metal gauge of branch duct (up to 16 gauge).
 - 2. Check extractors, scoops and splitter blades thoroughly for freedom of operation. Oil bearing points before installing.
- E. Use pushrod operator with locking nut and butt hinges assembly.
- F. Provide opposed-blade volume dampers with an appropriate control device in each of the following locations:
 - 1. Return air ductwork
 - 2. Outside air branch duct
 - 3. Exhaust branch duct
 - 4. Exhaust connections to hoods except kitchen grease hoods or equipment

5. In each zone at multi-zone unit discharge installed downstream of duct mounted re-heat coils
 6. At each outside air and return air duct connection to plenum of constant volume units
 7. At discharge side of constant volume boxes
 8. Where otherwise indicated or required for balancing coordinate location of additional dampers required by TAB Contractor.
 9. Provide multi-blade dampers when blade width exceeds 12". Provide end bearing where damper shaft penetrates duct wall.
- G. Elbows:
1. Rectangular: Where square elbows are shown, or are required for good airflow, provide and install single-wall or airfoil turning vanes. Job-fabricated turning vanes, if used, shall be single-thickness vanes of galvanized steel sheets of the same gauge metal as the duct in which they are installed. Furnish vanes fabricated for the same angle as the duct offset. The use of radius elbows with a centerline radius of not less than 1-1/2 times the duct width may be provided in lieu of vaned elbows where space and air flow requirements permit.
 2. Round Oval Duct. Provide elbows with a centerline radius of 1-1/2 times the duct diameter or duct width. For round ducts, furnish smooth elbows or 5 piece, 90° elbows and 3 piece, 45° elbows.
- H. For control devices concealed by ceilings, furring, or in other inaccessible locations, furnish extension rods and appropriate recessed-type Young regulators, mounted on the surface of the ceiling or the furring, unless specified, or shown otherwise. Provide with chrome plated cover plates. Use only one mitered gear set for each control device.
- I. Install streamline deflectors at any point where dividing a sheet metal duct around piping or where other such obstruction is permitted. Where such obstructions occur in insulated ducts, fill space inside streamliner and around obstructions with glass fiber insulation.
- J. Insulated Flexible Duct:
1. Install in accordance with manufacturer's instructions, and the terms of its UL listing. Duct shall not exceed 6' in length. Make connections by use of sheet metal collars and stainless steel circular screw clamps. Clamps shall encircle the duct completely and be tightened with a worm gear operator to the point that will provide an airtight connection without unnecessary deformation of the duct. Provide one clamp on flexible duct and one clamp on external insulation. Vapor barrier jacket shall be tucked inside to conceal insulation material.
 2. Construct bends over 45° with sheet metal elbows.
- K. Duct Supports:
1. Horizontal ducts up to 40". Support horizontal ducts up to and including 40" in their greater dimension by means of #18 U.S. gauge galvanized iron strap hangers attached to the ducts by a minimum of two locations per side by means of screws, rivets or clamps, and fastened to inserts with toggle bolts, beam clamps or other approved means. Place supports on at least 8' centers. Use clamps to fasten hangers to reinforcing on sealed ducts.
 2. Horizontal ducts larger than 40". Support horizontal ducts larger than 40" in their greatest dimension by means of hanger rods bolted to angle iron trapeze hangers. Place supports on at least 8' centers in accordance with SMACNA Standards.
 3. Support vertical ducts where they pass through the floor lines with 1-1/2" x 1-1/2" x 1/4" angles for ducts up to 60". Above 60", the angles shall be increased in

- strength and sized on an individual basis considering space requirements.
4. Supports shall be suspended from structural or by independent support. Do not support from structural bridging. Upper attachments should be selected with a safety factor of 4 or 5 times actual load conditions and subject to Engineers approval. Double wrap straps over open web of joist.

- L. Branch connections for medium pressure ductwork shall be made with a conical lateral. Field installed conical branch ducts shall be minimum 20-gauge galvanized sheet metal, "Everdur" welded and coated with "Galvabar".

3.3 PLENUMS

- A. Return air plenums shall be rectangular galvanized sheet metal ductwork.
- B. Fabricate plenums upstream of fan of 16-gauge material.
- C. Fabricate plenums upstream of filters minimum 18-gauge material.

3.4 FLEXIBLE CONNECTIONS

- A. Where ducts connect to fans or air handling units that are not internally isolated, make flexible airtight connections using "Ventglas" fabric. The fabric shall be fire-resistant, waterproof and mildew resistant with a weight of approximately 30 ounces per square yard. Provide a minimum of 1/2" slack in the connections, and a minimum of 2-1/2" distance between the edges of the ducts. Also, provide a minimum of 1" slack for each inch of static pressure on the fan system. Fasten fabric to apparatus and to adjacent ductwork by means of galvanized flats or draw bands. Where connections are made in outdoor locations, seal fabric to metal with mastic.

3.5 ACCESS DOORS

- A. Install ductwork access doors as noted below, arranged for convenient access. Stencil each door for specific use. Install access doors in each of the following locations:
 1. Fire Dampers
 2. Smoke Dampers
 3. Smoke/fire Dampers
 4. Outside Air Dampers
 5. Duct Mounted Coils (up-stream)
 6. Control Dampers
- B. Size access door 1" smaller than ductwork.
 1. Available Sizes: 8", 10", 12", 18", 24"
- C. Construct access door air tight, and conform to recommendations of NFPA and SMACNA.
- D. Demonstrate suitability of access for the intended purpose. Install multiple access doors as required.

3.6 DUCT LINING

- A. Install glass fiber acoustical lining where shown on drawings. Secure to duct surfaces with Foster 85-62 / 85-60 or Childers CP-125-1 / CP-127 adhesive and sheet metal fasteners on 12" centers. Coat exposed edges and leading edges of cross-joints with

adhesive.

- B. Provide metal nosing that is either channeled or "Z" profiled or are integrally-formed from the duct wall securely installed over transversely oriented liner edges facing the air stream at fan discharge and at any interval of lined duct preceded by unlined duct.
- C. Refer to Insulation & Liner Detail on drawings for locations requiring liner to be installed.
- D. Do not install liner in multi-zone unit ductwork.

3.7 SEALING OF SEAMS AND JOINTS

- A. Seal supply, return, exhaust and outside air duct systems.

3.8 SCREENS

- A. Furnish and install screens on all duct, fan, etc., openings furnished by the Contractor that lead to, or are, outdoors; screens shall be No. 16 gauge, one-half inch (1/2") mesh in removable galvanized steel frame. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

3.9 CONNECTIONS TO LOUVERS

- A. Make watertight connections to all louvers. Ductwork behind louver shall have watertight soldered joints for a minimum of three feet and be sloped to bottom of louver. Lap duct to be over bottom louver blade where possible.
- B. Where plenums are installed on inside of louver, construct such that bottom of plenum will lap over bottom blade of louver to drain any water that may enter.

3.10 PLENUMS

- A. Construct plenums with galvanized steel framing members and galvanized sheet steel, cross braced and rigidly braced with galvanized angles. Gauges and bracing shall conform to SMACNA recommendations for ductwork of like sizes. Openings for fans, access doors, etc., shall be framed with galvanized steel angles.
- B. Provide access doors.

END OF SECTION 23 3113

SECTION 23 3416 - FANS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install fans, including centrifugal, axial and propeller types, with supplemental equipment.

1.2 RELATED WORK

- A. Division 23 Mechanical:
 - 1. Ductwork
 - 2. Vibration Isolation
 - 3. Air Balance
 - 4. Electrical Provisions of Mechanical Work

1.3 PERFORMANCE

- A. Provide fan type, arrangement, rotation, capacity, size, motor horsepower, and motor voltage as shown. Fan capacities and characteristics are scheduled on the drawings. Provide fans capable of accommodating static pressure variations of +10% of scheduled design at the design air flow.
- B. Rate fans according to appropriate Air Moving and Conditioning Association, Inc. (AMCA), approved test codes and procedures. Supply fans with sound ratings below the maximums permitted by AMCA Standards. All fans provided must be licensed to bear the Certified Ratings Seal.
- C. Statically and dynamically balance all fans.
- D. Motors shall be sized so that they do not operate within the motor service factor.
- E. Fans shall be capable of 120% of the scheduled air capacities.
- F. All static pressures shown on schedules are external to fans. Manufacturer shall add damper and accessory losses to scheduled value before selecting fan.

1.4 SUBMITTALS

- A. Submit fan performance curves with system operating point plotted on curves.
- B. Submit manufacturer's printed installation instructions.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Cook
- B. Greenheck
- C. Penn Barry Ventilator
- D. Twin City Fans

SALAS O'BRIEN

FANS
23 3416-1
Salas O'Brien Registration #F-4111

2.2 PROTECTIVE COATINGS

- A. Manufacturer's Standard. Apply to fans, motors and accessories, the manufacturer's standard prime coat and finish, except on aluminum surfaces or where special coatings are required.
- B. Galvanizing. After fabrication of the parts, hot-dip coat surfaces that require galvanizing. Where galvanizing is specified, a zinc coating may be used. After fabrication, apply the zinc coating and air-dry the coating to 95% pure zinc. Acceptable zinc coatings include Zincilate, Sealube, Amercoat, Diametcoat, or an approved equal.

2.3 SUPPLEMENTAL EQUIPMENT

- A. Motor Covers. Provide weatherproof motor covers for installations out of doors. Apply the same finish as used on the fan.
- B. Belt Drives:
 - 1. Unless otherwise specified for belt-driven fans, equip the fan motors with variable pitch sheaves. Select the sheave size for the approximate midpoint of adjustment and to provide not less than 20% speed variation from full open to full closed. Size drives for 150% of rated horsepower. Key the fan sheave to the fan shaft.
 - 2. Nonadjustable motor sheaves may be used for motor sizes over 15 horsepower, at the Contractor's option. However, if changing a nonadjustable sheave becomes necessary to produce the specified capacity, the change must be made at no additional cost.
 - 3. Provide belt guards and apply the same finish as used on the fan.
 - 4. Oil and heat resistant, nonstatic type belts.
 - 5. Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty, regreasable, ball type, in a pillow block, cast iron housing, selected for a minimum L50 life in excess of 200,000 hours at maximum catalog operating speed.
- C. Safety Disconnect Switch: Provide a factory-wired to motor, safety disconnect switch on each unit.
- D. Relief Vents and Air Inlets: Provide vents and inlets with aluminum frames and 1/2" mesh, galvanized bird screens. Include dampers where shown.
- E. Prefabricated Roof Curbs: Furnish prefabricated roof curbs as detailed. The minimum height is 14". Include a resilient pad on each roof curb so the equipment can be mounted on the top flange for proper seal. Coordinate roof slope and curb to ensure equipment is installed in level position. Provide double shell to protect insulation from damage.
- F. Dampers. Where automatic backdraft damper is scheduled:
 - 1. Multi-bladed.
 - 2. Heavy duty.
 - 3. Roll formed aluminum blades.
 - 4. Nylon bearings.
 - 5. Neoprene weather strip on blade edge.
- G. All fans are to be provided with a durable, deep etched, .025" thick, factory installed aluminum identification plate with the following information. Plates are to be furnished with four mounting holes.
 - 1. Fan mark as indicated on the Contract Drawings.

2. Serial number
3. Model number
4. Capacity (CFM) and static pressure.
5. Motor HP
6. Motor Amps
7. Manufacturer
8. Motor phase
9. Number of Belts/Make/Size
10. Motor volts

2.4 VENTILATION AND EXHAUST FANS

- A. Provide the ventilation and exhaust fans shown on the drawings.
- B. Provide each motor with internal overload protection.
- C. Provide each belt driven fan with approved, totally enclosed belt guard.
- D. Provide approved safety screen where inlet or outlet is exposed.
- E. Provide duct flanges where required for connections.
- F. Furnish kitchen hood exhaust fans with vented curb extension that meets NFPA 96, cleanout port, grease tap, curb seal, drain connection and hinge kit.
- G. Furnish supply fans with 1" aluminum, washable filter section.

2.5 ROOFTOP VENTILATION AND EXHAUST SYSTEMS

- A. Provide the rooftop ventilation and exhaust systems shown on the drawings.
- B. Provide each motor with internal overload protection.
- C. Components:
 1. Aluminum, stainless steel or plastic coated bird guard.
 2. Screws and fasteners of stainless steel or nonferrous material.
 3. All aluminum construction unless indicated otherwise on fan schedule.
- D. Welded construction, corrosion resistant fasteners, minimum 16 gauge marine alloy aluminum.
- E. Aluminum base shall be continuously welded curb cap corners.

2.6 GRAVITY ROOF-TOP INTAKE AND RELIEF VENTS

- A. Provide the rooftop intake and relief vent systems shown on the drawings.
- B. Provide with aluminum, stainless steel or plastic coated bird guard.
 1. Screws and fasteners of stainless steel or nonferrous material
 2. All aluminum construction
- C. Welded construction, corrosion resistant fasteners, minimum 16-gauge marine alloy aluminum.
- D. Aluminum base shall be continuously welded curb cap corners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fans according to the manufacturer's instructions and in the locations shown on the drawings. Ensure fan location is installed at minimum distance from roof edge to meet code requirements.
- B. Do not operate fans or fan powered devices for any purpose until ductwork is clean, filters in place, bearings lubricated and the fan has been run under observation.
- C. Roof mounted fans and gravity roof-top intake and relief vents shall be secured to the curb with stainless steel lag screws at a minimum of 6-inches on center. Follow manufacturer's installation instructions if they are more stringent. Install roof mounted equipment in a level position. Units shall be seated on properly sized curb. Gap between base of the fan and top of the curb shall be sealed with neoprene 1" x 1/4" gasket. Gasket shall be glued or attached with pressure sensitive adhesive.
- D. Install curbs and equipment in level position.
- E. Ceiling mounted in-line centrifugal blowers
 - 1. Shall be suspended from structure with 1/2-inch zinc plated all-thread rods secured to structure.
 - 2. Provide sub-structure where required.
 - 3. Mount bottom of fan no more than 18-inches above the finished ceiling height.

3.2 EXTRA MATERIALS

- A. Provide two sets of belts for each fan, not including the set installed on the fans. Tag set to identify fan.

END OF SECTION 23 3416

SECTION 26 0105 - ELECTRICAL OPERATING AND MAINTENANCE MANUALS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Compile electrical product data and related information appropriate for Owner's operation and maintenance of products furnished under Contract. Prepare electrical operating and maintenance data as specified in this Section and as referenced in other sections of specifications.
- B. Instruct Owner's personnel in operation and maintenance of equipment and systems.
- C. Submit 3 copies of complete manual in final form.

1.2 ELECTRICAL OPERATING AND MAINTENANCE MANUAL SUBMITTAL SCHEDULE

- A. Thirty (30) days after receipt of reviewed submittals bearing the Architect / Engineer's stamp of acceptance (including re-submittals), submit for review 1 copy of the first draft of the Electrical Operating and Maintenance Manual. This copy shall contain as a minimum:
 - 1. Table of Contents for each element
 - 2. Contractor information
 - 3. All shop drawings, coordination drawings and product data, bearing the Architect / Engineer's stamp of acceptance.
 - 4. All parts and maintenance manuals for items of equipment
 - 5. Warranties (without starting dates)
 - 6. Certifications that have been completed; submit forms and outlines of certifications that have not been completed
 - 7. Operating and maintenance procedures.
 - 8. Form of Owner's Training Program Syllabus (including times and dates)
 - 9. Control operations / equipment wiring diagrams
 - 10. Coordination Drawings
 - 11. Schedule of Lamps, Light Engines
 - 12. Schedule of Ballasts and Drivers
 - 13. Schedule of Fuses
 - 14. Other required operating and maintenance information that are complete.
- B. Copy will be returned to the Contractor within 15 days with comments for corrections.
- C. Submit the (3) completed manuals in final form to the Architect / Engineer.
 - 1. Prior to substantial completion for Owner's use after the Owner accepts facility maintenance.
 - 2. Include all specified data, test reports, drawings, dated warranties, certificates, along with other materials and information.
- D. The Architect / Engineer shall review the manuals for completeness within 15 days.
- E. The Contractor shall be notified of any missing or omitted materials. The Manuals shall be reworked by the Contractor, as required, in the office of the Architect / Engineer. The manuals will not be retransmitted.
- F. Three complete manuals shall be delivered to the Owner prior to substantial completion.

PART 2 - PRODUCTS

2.1 BINDERS

- A. Commercial quality black, 3-ring binders with clear, durable, cleanable plastic covers.
- B. Minimum ring size: 1"; Maximum ring size: 3".
- C. When multiple binders are used, correlate the data into related groupings.
- D. Label contents on spine and face of binder with full size insert. Label under plastic cover.

PART 3 - EXECUTION

3.1 ELECTRICAL OPERATION AND MAINTENANCE MANUAL

- A. Form for Manuals:
 - 1. Prepare data in form of an instructional manual for use by Owner's personnel.
 - 2. Format:
 - a. Size: 8-1/2" x 11"
 - b. Text: Manufacturer's printed data or neatly typewritten.
 - 3. Drawings:
 - a. Provide reinforced punched binder tab and bind in text.
 - b. Fold larger drawings to size of text pages.
 - 4. Provide flyleaf indexed tabs for each separate product or each piece of operating equipment.
 - 5. Cover: Identify each volume with typed or printed title "Operating and Maintenance Instructions". List:
 - a. Title of Project
 - b. Identity of separate structures as applicable
 - c. Identity of general subject matter covered in the manual.
 - 6. Binder as specified
- B. Content of Manual:
 - 1. Neatly typewritten Table of Contents for each volume arranged in systematic order as outlined in the specifications.
 - a. Contractor, name of responsible principal, address and telephone number
 - b. A list of each product required to be included, indexed to content of the volume.
 - c. List with each product, name, address and telephone number of:
 - 1) Subcontractor or installer
 - 2) Maintenance contractor as appropriate
 - 3) Identify area of responsibility of each.
 - 4) Local source of supply for parts and replacement
 - d. Identify each product-by-product name and other identifying symbols as set forth in Contract Documents.
 - 2. Product Data:
 - a. Include those sheets pertinent to the specific product.
 - b. Annotate each sheet to:
 - 1) Identify specific product or part installed.
 - 2) Identify data applicable to installation.
 - 3) Delete references to inapplicable information.
 - 3. Drawings:
 - a. Supplement product data with drawings as necessary to illustrate:

- 1) Relations of component parts of equipment and systems
 - 2) Control and flow diagrams
 - b. Coordinate drawings with information in Project Record Documents to assure correct illustration of completed installation.
 - c. Do not use Project Record Documents as maintenance drawings.
 4. Written text as required to supplement product data for the particular installation:
 - a. Organize in consistent format under separate headings for different procedures.
 - b. Provide logical sequence of instructions for each procedure.
 5. Copy of each warranty, bond and service contract issued
 - a. Provide information sheet for Owner's personnel, giving:
 - 1) Proper procedures in event of failure
 - 2) Instances that might affect validity of warranties or bonds
 6. Shop drawings, coordination drawings and product data as specified.
- C. Sections for Equipment and Systems
1. Content for each unit of equipment and system as appropriate:
 - a. Description of unit and component parts:
 - 1) Function, normal operating characteristics, and limiting conditions.
 - 2) Performance curves, engineering data and tests.
 - 3) Complete nomenclature and commercial number of replaceable parts.
 - b. Operating procedures:
 - 1) Start up, break-in, routine / normal operating instructions
 - 2) Regulation, control, stopping, shut down and emergency instructions
 - 3) Summer and winter operating instructions
 - 4) Special operating instructions
 - c. Maintenance procedures:
 - 1) Routine operations
 - 2) Guide to trouble-shooting
 - 3) Disassembly, repair and reassembly
 - 4) Alignment, adjusting and checking
 - 5) Routine service based on operating hours
 - d. Servicing and lubrication schedule
 - 1) List of lubricants required
 - e. Manufacturer's printed operating and maintenance instructions.
 - f. Copies of typed circuit directories of panel board to reflect actual room graphics numbers and room names (not architectural room numbers from the drawings).
 - 1) Electrical
 - 2) Controls
 - 3) Communications
 - g. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance.
 - 1) Predicted life of part subject to wear
 - 2) Items recommended to be stocked as spare parts
 - h. Schedule of fuses
 - i. Complete equipment field accessible internal wiring diagrams
 - j. Schedule of lamps
 - k. Schedule of ballasts
 - l. Each Contractor's coordination drawings
 - m. List of original manufacturer's spare parts and recommended quantities to be maintained in storage

- n. Other data as required under pertinent sections of the specifications
2. Prepare and include additional data when the need for such data becomes apparent during instruction of Owner's personnel.
3. Additional requirements for operating and maintenance data as outlined in respective sections of specifications
4. Provide complete information for products specified in Division 26.
5. Provide certificates of compliance as specified in each related section.
6. Provide start up reports as specified in each related section.
7. Provide signed receipts for spare parts and material.
8. Provide training report and certificates.

END OF SECTION 26 0105

SECTION 26 0500 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Except as modified in this Section, General Conditions, and Supplementary Conditions, applicable provisions of Division 1 General Requirements, and other provisions and requirements of the Contract Documents apply to work of Division 26 Electrical.
- B. Applicable provisions of this section apply to all sections of Division 26, Electrical.

1.2 CODE REQUIREMENTS AND FEES

- A. Perform work in accordance with applicable statutes, ordinances, codes and regulations of governmental authorities having jurisdiction.
- B. Electrical work shall comply with applicable inspection services:
 - 1. Underwriters Laboratories
 - 2. National Fire Protection Association
 - 3. State Health Department
 - 4. Local Municipal Building Inspection Department adopted codes with amendments
 - 5. National Electrical Code with local amendments
 - 6. State Regulatory Agencies
 - 7. Where the project is located outside a municipal jurisdiction, and has no municipal inspection services, the National Electrical Code with amendments of the municipality with extraterritorial jurisdiction shall govern.
 - 8. Where the project is located outside any municipal jurisdiction, including extraterritorial jurisdictions, the National Electrical Code with local adopted amendments of the largest municipality located in the same county or parish shall govern.
 - 9. International Energy Conservation Code
 - 10. National Electrical Safety Code
- C. Resolve any code violations discovered in contract documents with the Engineer prior to award of the contract. After Contract award, any correction or additions necessary for compliance with applicable codes shall be made at no additional cost to the Owner.
- D. This Contractor shall be responsible for being aware of and complying with asbestos NESHAP regulations, as well as all other applicable codes, laws and regulations.
- E. Obtain all permits required.

1.3 CONTRACTOR'S QUALIFICATIONS

- A. An approved contractor for the work under this division shall be:
 - 1. A specialist in this field and have the personnel, experience, training, and skill, and the organization to provide a practical working system.
 - 2. Able to furnish evidence of having contracted for and installed not less than 3 systems of comparable size and type that has served their Owners satisfactorily for not less than 3 years.

1.4 REFERENCE SPECIFICATIONS AND STANDARDS

- A. Materials which are specified by reference to Federal Specifications; ASTM, ASME, ANSI, APWA, or AWWA Specifications; Federal Standards; or other standard specifications

must comply with latest editions, revisions, amendments or supplements in effect on date proposals are received. Referenced specifications and standards are minimum requirements for all equipment, material and work. In instances where specified capacities, size or other features of equipment, devices or materials exceed these minimums, meet specified capacities.

- B. Use electrical materials and equipment that is constructed and tested in accordance with the standards of NEMA, ANSI, ASTM, or other recognized commercial standard. If materials and equipment is labeled, listed, or recognized by any Nationally-Recognized Testing Laboratory (NRTL) acceptable to the Occupational Safety and Health Administration (OSHA), then provide NRTL-labeled, listed, or recognized material and equipment. Acceptable NRTLs include but are not limited to:
1. Underwriters Laboratories, Inc. (UL)
 2. Factory Mutual Research Corp. (FMRC) (also referred to as "Factory Mutual Global," or "FM Global")
 3. Intertek Testing Services NA, Inc. (ITSNA, formerly ETL)
 4. Canadian Standards Association (CSA)
 5. A complete listing of acceptable NRTLs is published on the OSHA website at <http://www.osha.gov/dts/otpca/nrtl/>.
- C. Where material and equipment is not labeled, listed, or recognized by any NRTL, provide a manufacturer's Certificate of Compliance indicating complete compliance of each item with applicable standards of NEMA, ANSI, ASTM, or other recognized commercial standard.
- D. Do not install or use electrical material or equipment for any use other than that for which it was designed, labeled, listed, or identified unless formally approved for such use by the Owner's AHJ. This *National Electrical Code*® requirement is re-stated for emphasis.
- E. Codes and Standards applicable to this Division:
1. ANSI – American National Standards Institute
 - a. ANSI Z535.1, Safety Colors
 - b. ANSI Z535.2, Environmental and Facility Safety Signs
 - c. ANSI Z535.3, Criteria for Safety Symbols
 - d. ANSI Z535.4, Product Safety Signs and Labels
 2. ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers:
 - a. ASHRAE Standard 90.1, *Energy Standards for Buildings Except for Low Rise Residential Buildings [ANSI, IESNA]*
 3. ASTM – American Society for Testing and Materials
 4. CBM – Certified Ballast Manufacturers
 5. ICC – International Code Council
 - a. International Building Code® (IBC)
 - b. International Existing Building Code® (IEBC)
 6. ICEA – Insulated Cable Engineers Association
 - a. ICEA S-93-639, *Shielded Power Cables 5-46kV (NEMA WC-74)*
 7. IEEE® - Institute of Electronics and Electrical Engineers
 - a. IEEE C2™, *National Electrical Safety Code (NESC) [ANSI]*
 - b. IEEE Std 141™, *Recommended Practice for Electric Power Distribution for Industrial Plants ("Red Book")*
 - c. IEEE Std 143™, *Recommended Practice for Grounding of Industrial and Commercial Power Systems ("Green Book")*
 - d. IEEE Std 241™, *Recommended Practice for Electric Power Systems in Commercial Buildings ("Gray Book")*

- e. IEEE Std 242™, *Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems* (“Buff Book”)
- f. IEEE Std 315™, *Graphic Symbols for Electrical and Electronics Diagrams*
- g. IEEE Std 399™, *Recommended Practice for Power Systems Analysis* (“Brown Book”)
- h. IEEE Std 446™, *Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications* (“Orange Book”)
- i. IEE Std 493™, *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems* (“Gold Book”)
- j. IEEE Std 519™, *Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems*
- k. IEEE Std 739™, *Recommended Practice for Energy Management in Industrial and Commercial Facilities* (“Bronze Book”)
- l. IEEE Std 902™, *Guide for Maintenance, Operation, and Safety of Industrial and Commercial Power Systems* (“Yellow Book”)
- m. IEEE Std 1015™, *Recommended Practice Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems* (“Blue Book”)
- n. IEEE Std 1100™, *Recommended Practice for Powering and Grounding Electronic Equipment* (“Emerald Book”)
- o. IEEE Std 1584™, *Guide for Performing Arc-Flash Hazard Calculations*
- 8. IESNA – Illuminating Engineering Society of North America
 - a. IESNA *Lighting Handbook*, Ninth Edition
 - b. IESNA RP-1, *American National Standard Practice for Office Lighting*
 - c. IESNA RP-7, *American National Standard Practice for Lighting Industrial Facilities*
- 9. NECA – National Electrical Contractors Association:
 - a. NECA 1, *Good Workmanship in Electrical Construction* [ANSI]
 - b. NECA 90, *Recommended Practice for Commissioning Building Electrical Systems* [ANSI]
 - c. NECA 100, *Symbols for Electrical Construction Drawings* [ANSI]
 - d. NECA 101, *Standard for Installing Steel Conduits (Rigid, IMC, EMT)* [ANSI]
 - e. NECA 104, *Recommended Practice for Installing Aluminum Building Wire and Cable* [ANSI]
 - f. NECA / NEMA 105, *Recommended Practice for Installing Metal Cable Tray Systems* [ANSI]
 - g. NECA 111, *Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC)* [ANSI]
 - h. NECA / NACNA 120, *Standard for Installing Armored Cable (Type AC) and Metal-Clad Cable (Type MC)*[ANSI]
 - i. NECA 202, *Recommended Practice for Installing and Maintaining Industrial Heat Tracing Systems* [ANSI]
 - j. NECA 230, *Standard for Selecting, Installing and Maintaining Electric Motors and Motor Controllers* [ANSI]
 - k. NECA 331, *Standard for Building and Service Entrance Grounding and Bonding*
 - l. NECA 400, *Standard for Installing and Maintaining Switchboards* [ANSI]
 - m. NECA 402, *Standard for Installing and Maintaining Motor Control Centers* [ANSI]
 - n. NECA / EGSA 404, *Standard for Installing Generator Sets* [ANSI]
 - o. NECA 407, *Recommended Practice for Installing and Maintaining Panelboards* [ANSI]

- p. NECA 408, *Recommended Practice for Installing and Maintaining Busways* [ANSI]
- q. NECA 409, *Recommended Practice for Installing and Maintaining Dry-Type Transformers* [ANSI]
- r. NECA 410, *Recommended Practice for Installing and Maintaining Liquid-Filled Transformers* [ANSI]
- s. NECA 411, *Recommended Practice for Installing and Maintaining Uninterruptible Power Supplied (UPS)* (ANSI)
- t. NECA 420, *Standard for Fuse Applications* [ANSI]
- u. NECA 430, *Standard for Installing Medium-Voltage Metal-Clad Switchgear* [ANSI]
- v. NECA / IESNA 500, *Recommended Practice for Installing Indoor Lighting Systems* [ANSI]
- w. NECA / IESNA 501, *Recommended Practice for Installing Exterior Lighting Systems* [ANSI]
- x. NECA / IESNA 502, *Recommended Practice for Installing Industrial Lighting Systems* [ANSI]
- y. NECA / MACSCB 600, *Recommended Practice for Installing and Maintaining Medium-Voltage Cable* [ANSI]
- z. NECA / NEMA 605, *Installing Underground Nonmetallic Utility Duct* [ANSI]
- 10. NEMA – National Electrical Manufacturers Association
- 11. NETA – International Electrical Testing Association, Inc.:
 - a. NETA ATS, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*
 - b. NETA MTS, *Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*
 - c. NETA ETT, *Standard for Certification of Electrical Testing Technicians* [ANSI]
- 12. NFPA – National Fire Protection Association:
 - a. NFPA 20®, *Standard for the Installation of Stationary Pumps for Fire Protection*®
 - b. NFPA 70™, *National Electrical Code*® (NEC®)
 - c. NFPA 70E, *Standard for Electrical Safety in the Workplace*.
 - d. NFPA 101®, *Life Safety Code*®
 - e. NFPA 110, *Standard for Emergency and Standby Power Systems*
 - f. NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*
 - g. NFPA 780, *Standard for the Installation of Lightning Protection Systems*
 - h. All other NFPA codes and standards except NFPA 5000
- 13. OSHA – Occupational Safety and Health Administration
- 14. IECC – International Energy Conservation Code
- 15. ISO – International Organization for Standardization
- 16. State and Local Energy Conservation Code
- 17. Applicable County and Municipal Codes

1.5 CONTRACT DRAWINGS

- A. Contract drawings are diagrammatic only and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements.
- B. Every effort has been made by the Engineer to indicate wiring of all receptacles, light fixtures, switches, telephone outlets, HVAC equipment, other equipment, elevator equipment, and all other devices / appliances requiring electrical power. It is the intent of the Engineer that all light fixtures be powered and controlled unless specifically noted on

the plans; that all wiring devices (receptacles and direct connected equipment) be circuited to a power source of the correct voltage and that all HVAC, elevator equipment and other equipment be properly wired to the correct voltage power source; that all communications and security systems devices and equipment and all fire alarm system devices and equipment are installed, wired and systems are fully operational.

- C. It is the responsibility of the Contractor to review the construction drawings (reflected ceiling plans) for light fixtures, casework elevation details for electrical devices which are not indicated on the electrical drawings; to review the mechanical and plumbing documents and all other drawings to determine the electrical rough-ins for all equipment requiring power connections, and to include in their proposals the correct and complete electrical rough-ins for all of these items which were inadvertently not indicated on the electrical drawings, OR the Contractor shall specifically enumerate each item requiring electrical rough-in which is not specifically shown on the electrical drawings, and indicate the electrical provisions of these items as specifically excluded from his proposal.
- D. It is the responsibility of the Contractor to compare the scale of all electrical drawings with the scale of the architectural drawings and make adjustments to all electrical drawings which have the incorrect drawing scale so that his material takeoffs are not in error due to an incorrectly labeled drawing scale and his proposal is complete.
- E. No proposal shall be accepted which specifically excludes any of the provisions of paragraphs B, C, or D above.

1.6 PROJECT RECORD DOCUMENTS

- A. Maintain at the job site a separate set of white prints (black line) of the contract drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the contract drawings. Mark the drawings with a colored pencil. Prepare, as the work progresses and upon completion of work, reproducible drawings clearly indicating locations of various major and minor feeders, equipment, and other pertinent items, as installed. Record underground and under slab service and feeders installed, dimensioning exact location and elevation of such installations.
- B. At conclusion of project, obtain without cost to the Owner, electronic PDF and AutoCAD 2014 and / or Revit CAD files of the original drawings and transfer as-built changes to these. Provide the following as-built documents including all contract drawings regardless of whether corrections were necessary and include in the transmittal: "2 sets of CDs and prints for Owner's use, one set of CDs, prints, and mylars for Architect / Engineers Records". Delivery of these as-built electronic, reproducible and prints is a condition of final acceptance.
 - 1. 3 sets of electronic AutoCAD (2014 dwg) and / or Revit CAD drawing files, on CD-ROM media, of each contract as-built drawing.
 - 2. One reproducible Dayrex Mylar film positive of each contract as-built drawing.
 - 3. Three sets of blue-line prints of each contract as-built drawing.
 - 4. Three sets of pdf prints of each contract as-built drawing on CD.
- C. As-Built Drawings should indicate the following information as a minimum:
 - 1. Indicate all addendum changes to documents.
 - 2. Remove Engineer's Seal, name, address, and logo from drawings.
 - 3. Mark documents RECORD DRAWINGS.
 - 4. Clearly indicate: DOCUMENT PRODUCED BY:
 - 5. Indicate all changes to construction during construction. Indicate actual routing of all conduits, etc. that was deviated from construction drawings.
 - 6. Indicate exact location of all underground electrical raceways, and elevations.

7. Correct schedules to reflect (actual) equipment furnished and manufacturer.
8. During the execution of work, maintain a complete set of Drawings and specifications upon which all locations of equipment, devices, and all deviations and changes from the construction documents in the work shall be recorded.
9. Exact location of all electrical equipment in building. Label panel schedules to indicate actual location.
10. Exact location of all electrical equipment in and outside of the building.
11. Exact location of all outdoor lighting poles and equipment.
12. Location, size and routing of all feeder conduits, equipment, etc. shall be accurately and neatly shown to dimension.
13. Exact location of all roof mounted equipment, wall, roof and floor penetrations.
14. Cloud all changes.
15. Update all panel schedules with all additional circuits added or deleted through construction. Identify each circuit to include all information specified for directory cards for circuit identification in panelboards.

1.7 SPACE REQUIREMENTS

- A. Consider space limitations imposed by contiguous work in selection and location of equipment and material. Do not provide equipment or material that is not suitable in this respect.

1.8 RELATION WITH OTHER TRADES

- A. Carefully study all matters and conditions concerning the project. Submit notification of conflict in ample time to prevent unwarranted changes in any work. Review other Divisions of these specifications to determine their requirements. Extend electrical services and final connections to all items requiring same.
- B. Because of the complicated relationship of this work to the total project, conscientiously study the relation and cooperate as necessary to accomplish the full intent of the documents.
- C. Provide sleeves and inserts in forms as required for the work. Stub up and protect open ends of pipe before any concrete is placed. Furnish sizes of required equipment pads. Furnish and locate bolts and fittings required to be cast in them.
- D. Locate and size openings required for installation of work specified in this Division in sufficient time to prevent delay in the work.
- E. Refer to other Divisions of the specifications for the scope of required connections to equipment furnished under other Division. Determine from the General Contractor / Construction Manager for the various trades, the Owner, and by direction from the Architect / Engineer, the exact location of all items. The construction trades involved shall furnish all roughing-in drawings and wiring diagrams required for proper installation of the electrical work.
 1. Make final electrical connections to all electrically operated equipment indicated on the drawings, except as noted.
 2. The responsibility for alignment of motor and driven equipment is specified in the related division.
- F. Request all Shop Drawings required in ample time to permit proper installation of all electrical provisions.

- G. Extend services as indicated to the various items of equipment furnished by others. Rough-in for the various items and make final connections ready for operation upon placing of the equipment.

1.9 CONCEALED AND EXPOSED WORK

- A. When the word "concealed" is defined as hidden from sight as in chases, furred spaces or above ceilings. "Exposed" is defined as open to view, in plain sight.

1.10 GUARANTEE

- A. Guarantee work for 1 year from the date of substantial completion of the project. During that period make good any faults or imperfections that may arise due to defects or omissions in material, equipment or workmanship. Replacement of failed parts or equipment shall be provided.

1.11 MATERIAL AND EQUIPMENT

- A. Furnish new and unused materials and equipment meeting the requirements of the paragraph specifying acceptable manufacturers. Where two or more units of the same type or class of equipment are required, provide units of a single manufacturer.

1.12 NOISE AND VIBRATION

- A. Select equipment to operate with minimum noise and vibration. If noise or vibration is produced or transmitted to or through the building structure by equipment, piping, ducts or other parts of work, and judged objectionable by the Owner, Architect, or Engineer, rectify such conditions at no additional cost to the Owner. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate at no additional cost that equipment performs within designated limits on a vibration chart.

1.13 ACCEPTABLE MANUFACTURERS

- A. Manufacturers names and catalog number specified under sections of Division 26 are used to establish standards of design, performance, quality and serviceability and not to limit competition. Equipment of similar design, materials, energy efficiency characteristics (where applicable) and lighting performance characteristics (where applicable) equal to that specified, manufactured by a named manufacturer shall be acceptable on approval. A request for prior approval of equipment not listed must be submitted ten (10) days before proposal due date. Submit a marked-up set of the relevant specification section indicating all variances, a comparison to the specified product, and of construction and performance criteria, complete design and performance data for the specified product and the proposed substitution for comparison to the Engineer. The Architect issues approvals of acceptable manufacturers as addenda to the Construction Proposal Documents.

1.14 UTILITIES, LOCATIONS AND ELEVATIONS

- A. Locations and elevations of the various utilities included within the scope of this work:
 1. Obtained from utility maps and other substantially reliable sources.
 2. Are offered separate from the Contract Documents as a general guide only without guarantees to accuracy.
- B. Examine the site and verify the location and elevation of all utilities and of their relation to the work. Existing utilities indicated on the site plans are for reference only and shall be field verified by the Contractor with the respective public or private utility.

1.15 OPERATING TESTS

- A. After all electrical systems have been completed and put into operation, subject each system to an operating test under design conditions to ensure proper sequencing and operation throughout the range of operation. Tests shall be made in the presence of the Architect / Engineer and Owner. Provide minimum 24-hour advance notice of scheduling of all tests. Make adjustments as required to ensure proper functioning of all systems. Special tests on individual systems are specified under individual sections. Submit 3 copies of all certifications and test reports adequately in advance of completion of the work to allow for remedial action as required to correct deficiencies discovered in equipment and systems.

1.16 WARRANTIES

- A. All normal and extended warranties shall include parts, labor, miscellaneous materials, travel time, incidental expenses, normal freight / shipping, refrigerant, oils, lubricants, belts, filters and any expenses related to service calls required to diagnose and correct warranty problems.
- B. Manufacturer's warranty shall be from one year from date of substantial completion. Contractor shall be responsible for extending the warranties regardless of date of installation or commissioning.
- C. Submit 3 copies of all warranties and guarantees for systems, equipment, devices and materials. These shall be included in the Operating and Maintenance Manuals.

1.17 BUILDING CONSTRUCTION

- A. It shall be the responsibility of the sub-contractor to consult the Contract Drawings, details and specifications and thoroughly familiarize himself as to the construction and all job related requirements. All construction trades shall cooperate with the General Contractor / Construction Manager Job site superintendent and lay out work so that all raceways and other items are placed in the walls, furred spaces, chases, etc., so that there shall be no delay in the job.

1.18 TEMPORARY FACILITIES

- A. General: Refer to Division 1 for general requirements on temporary facilities.
- B. Temporary Wiring: Temporary power and lighting for construction purposes shall be provided under this Division. Installation of temporary power shall be in accordance with NEC Article 527.
- C. Temporary facilities, wire, lights and devices are the property of this Contractor and shall be removed by this Contractor at the completion of the Contract.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 IDENTIFICATION OF EQUIPMENT

- A. Identification of Equipment:
 - 1. All major equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers, equipment size,

- and other pertinent data. Take care not to obliterate this nameplate. The legend on all nameplates or tags shall correspond to the identification shown on the Operating Instructions. All panels, cabinets, or equipment requiring 120 volt or higher power shall be labeled as required which includes circuit designation and circuit panelboard location, regardless of which discipline installs the equipment.
2. Three layer laminated plastic engraved identifying nameplate shall be permanently secured to each switchboard, distribution panel, motor control center, transformer, panelboard, safety disconnect switch, enclosed circuit breaker, transfer switches, remote generator transfer devices not installed inside light fixtures, wireway, busduct plug, terminal cabinet, surge protective device, capacitor, individual motor controller, contactor, fire alarm panels (main and remote booster), and communications (voice, data, video) cabinet or rack, security panels, time clocks, BMCS cabinets, sound reinforcement cabinets and racks, miscellaneous control cabinets, equipment integral disconnect switches, toggle or motor switches, disconnects for equipment, exterior junction boxes, exterior pull boxes, exterior wireways and gutters, and rooftop equipment (i.e.: supply and exhaust fans, rooftop HVAC equipment) with stainless steel screws.
 - a. Utility Power: White letters on black background
 Generator Power (White letters on red background)
 UPS Power: White letters on blue background
 Load Bank Circuits: White letters on green background
 Solar or Wind Power Generation: White on orange background
 - b. Identifying nameplates shall have 1/2-inch high, engraved letters for equipment designation and 1/4-inch letters indicating source circuit designation, (i.e.: "PANEL HA –fed from MDP-6 located in Mech. Rm. 100"). The words "fed from" and "located" shall be included in the labeling.
 - c. Each switchboard, distribution panel, transfer switch, generator transfer device (GTD) for emergency lighting, and motor control center feeder or branch circuit device shall have a nameplate showing the load and location of load served in 1/4-inch high, engraved letters. Circuit breaker name and kirk key designation if applicable
 - d. Each section of multiple section panelboards shall also indicate panelboard section number (i.e.: Panel "HA-Section 2 – fed from MDP-6 located in Mech. Rm. 100")
 - e. Motor Controllers, starters, and contactors: Provide neatly typed label inside each motor controller and contactor enclosure door identifying motor or load served, nameplate horsepower, full load amperes, code letter, service factor, and voltage / phase rating.
 - f. Individual motor controller and contactor nameplates shall include load served, location of load served, panel and circuit numbers serving load, location of panel serving load, panel and circuit number serving control circuit, location of panel serving control circuit (if different from panel serving load), description and location (if applicable) of control controlling contactor (i.e. Controlled: Switch in RM 100, and Controlled: BMCS). Contactor nameplate is to include whether it is a lighting or receptacle contactor and name of contactor. i.e. C-1.

Lighting Contactor Example	Receptacle Contactor Example
Lighting Contactor C1	Receptacle Contactor C2
West Parking Lot Pole Lights	Table Recpts Lab Rm 100
Fed From Panel HA-2,4,6	Fed From Panel LA-2,4,6,8
Located Main Elec. Rm. 100	Located Mech. Rm. 110
Control Circuit-Panel LA 42	Control Circuit-Panel LA-42
Located Main Elec. Rm. 100	Controlled-Emer Shut Off Mushroom
Controlled-BMCS	Switch Rm 101

- g. Exterior J-boxes, pull boxes, and gutters shall have panel identification, circuit numbers, and location of panel listed on name plate. Low voltage shall be identified per contents, examples: DATA, BMCS, F/A
- h. Name plates on equipment served from switchboards, distribution panels, I-Line panels, and motor control centers are not to include circuit numbers shown on drawings as the circuit numbers are for construction drawing purposes only.
- i. Panel names for 277/480v shall start with the letter "H" and 120/208v, 120/240v shall start with the letter "L". No panel shall be named to include a number other than multi sectional panels, example HA-section 2. New panels installed in renovation or site additions shall have names approved or designated by Owner's electrical representative. Panel names shall not include the letter "I". Transformer names shall start with the letter "T" followed by the panel name it serves, i.e. TLA.
- j. Main service ATS label shall include equipment name, emergency source and location, normal power source and location, panel served and location. Wall mounted ATS serving lighting loads shall include type of lighting and location, emergency panel and circuit ID and location of panel, normal panel and circuit ID and location of panel.

Main Service ATS Example	Wall Mounted Lighting ATS Example
ATS-1	ATS
Emer Power-Emer Generator	Exterior Wall Packs/Soffit Lights
Located Chiller Yard	North/West Metal Canopy Lights
Normal Power-MSB	Fed from EHA-2
Located-Mech Rm 100	Located Mech Rm 200
Serves Panel EHA	Fed From HB-4
Located-Mech Rm 100	Located Mech Rm 150
- k. Name plates shall include rated bus amperage, voltage, number of phases, number of wires and type of essential electrical system as applicable.
- l. Service equipment available fault current labeling: Provide a 2x3 inch label with blue lettering on contrasting background permanently affixed to the service disconnect/equipment prior to energizing the service equipment. The label shall include the date of installation and the date of calculation. The date of calculation shall be the date indicated by the Engineer of Record's Seal on the Construction Document Electrical One-Line Diagram / Riser Drawing. Example:

SERVICE EQUIPMENT AVAILABLE FAULT CURRENT: ##, ### AMPS
DATE OF INSTALLATION: MM/DD/YY
DATE OF CALCULATION: MM/DD/YY

- 3. Cardholders and directory cards shall be furnished for circuit identification in panelboards. Cardholder shall be located on inside of panel door and shall be in a metal frame with clear plastic front. Circuit lists shall be typewritten. Circuit descriptions shall include explicit description and identification of items controlled by each individual breaker, including final graphics room number or name designation and name of each item served. If no building appointed room number or name is given, list locations per the following examples – A. Storage in Rm 100 – B. Office in Rm 100 – C. Storage west of Rm. 100. List corridors as "corridors". Identify circuits controlled by contactors using a separate notation for each contactor used. List notation at bottom of schedule stating the circuits are controlled by a contactor, list exact location of contactor, and how switched. Do not use architectural room number designation shown on plans. Obtain final graphics room number identification from Architect's final room number graphics plan. All locations served by breakers shall be listed on schedule. Panel schedule

- shall be large enough to contain all information required. Also refer to Section 26 24 16.
4. Permanent, waterproof, black markers shall be used to identify each lighting and power grid junction box, gutter and wireway. Clearly indicate the panel and branch circuit numbers available at that junction box, gutter or wireway. Where low voltage relay panels are used for lighting control, identify the low voltage relay panel and number in addition to the branch circuit panel and number.
 5. Pull Boxes, Transformers, Disconnect Switches, etc.: Field work each with a name plate showing identity, voltage and phase and identifying equipment connected to it. The transformer rating shall be shown on the panels or enclosures. For an enclosure containing a motor starter, the nameplate shall include the Owner's motor number, motor voltage, number of motor phases, motor load being serviced, motor horsepower, and motor full load current. Nameplates shall also indicate where panel is fed from.
- B. Prohibited Markings: Markings intended to identify the manufacturer, vendor, or other source from whom the material has been obtained are prohibited for installation in public, tenant, or common areas within the project. Also prohibited are materials or devices that bear evidence that markings or insignias have been removed. Certification, testing (example, Underwriters Laboratories), and approval labels are exceptions to this requirement.
- C. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of electrical facilities. Provide text of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with industry standards for color and design.
- D. Wire and Cable Markers: Provide vinyl cloth markers with split sleeve or tubing type, except in manholes provide stainless steel with plastic ties.
- E. Wire and Cable Labeling: Provide wire markers on each conductor in all boxes, pull boxes, gutters, wireways, contactors, and motor controllers and load connection. Identify with panelboard / switchboard branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.
- F. Underground Warning Tape: Thomas and Betts or approved equal. Six-inch wide plastic tape, colored red for 50 volts or above electrical, or orange for communications and control with suitable warning legend describing buried electrical lines; telephone lines and data lines per APWA recommendations. All underground electrical conduits shall be so identified. Tape shall be buried at a depth of 6-inches below grade and directly above conduits or ductbanks. Provide magnetic marking tape below all underground electrical conduits.
- G. Lighting Controls and Equipment: Provide self-adhesive machine typed tape labels with $\frac{1}{4}$ " high white letters on $\frac{1}{2}$ " tall black background for digital lighting modules as "DLM". Modules or relays located above ceiling: adhere label to bottom of ceiling T-grid below relay location. Modules or relays located in mechanical or electrical rooms or other areas other than above ceiling: Adhere label to the cover of the module or relay and identify the area they control as "MAIN GYM", "BAND HALL", or "CORRIDOR 100", etc. Remote lighting control switches or push button stations located remotely from the area they control: Adhere label to device face plate, not obstructing screw fasteners, and intuitively identify function such as "GYM LTG LOW-HIGH" or "CAFE LTG DIM", etc.

3.2 CUTTING AND PATCHING

- A. General: Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of electrical work. Except as authorized by the Architect / Engineer, cutting and patching of electrical work to accommodate the installation of other work is not permitted.

3.3 INSTRUCTION OF OWNER'S PERSONNEL

- A. Prior to substantial completion, conduct an on-site training program to instruct Owner's operating personnel in the operation and maintenance of the electrical systems.
 - 1. Provide the training during regular working day.
 - 2. The Instructors shall be experienced in their phase of operation and maintenance of the electrical systems and with the project.
 - 3. Refer to other specification sections for additional training and commissioning requirements.
- B. Time to be allocated for instructions.
 - 1. Minimum of 1 hours dedicated instructor time
 - 2. 1 hours on each of 1 days
 - 3. Additional instruction time for specific systems as specified in other Sections.
- C. Before on-site training, submit the program syllabus; proposed time and dates; for review and approval, minimum 48 hours prior to proposed training time and date.
 - 1. One copy to the Owner
 - 2. One copy to the Architect / Engineer
- D. The Owner shall provide a list of personnel to receive instructions, and shall coordinate their attendance at the agreed upon times.
- E. Use operation and maintenance manuals as the basis of instruction. Review manual with personnel in detail. Explain all aspects of operation and maintenance.
- F. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut down of each item of equipment.
- G. Demonstrate equipment functions (both individually and as part of the total integrated system).
- H. Prepare and insert additional data in the operating and maintenance manuals when the need for additional data becomes apparent during instructions.
- I. Submit a report within one week after completion of training. List time and date of each demonstration, hours devoted to the demonstration, and a list of people present, with their respective signatures.
- J. At the conclusion of the on-site training program, have the person designated by the Owner sign a certificate to certify that he / she has a proper understanding of the system, that the demonstrations and instructions have been satisfactorily completed, and the scope and content of the operating and maintenance manuals used for the training program are satisfactory.
- K. Provide a copy of the report and the certificate in an appropriately tabbed section of each Operating and Maintenance Manual.

3.4 OPENINGS

- A. Framed, cast or masonry openings for boxes, equipment or conduits are specified under other divisions. Drawings and layout work for exact size and location of all openings are included under this division.

3.5 HOUSEKEEPING PADS

- A. Provide concrete equipment housekeeping pads under all floor and outdoor mounted electrical equipment.
- B. Concrete and reinforcing steel shall be as specified in Division 3, or as indicated or noted.
- C. Concrete pads:
 - 1. 6-inches thick minimum indoors; 8-inches thick minimum outdoors, or match existing if indicated on the drawings to extend existing pads, or in other sections of the specifications.
 - 2. Chamfer strips at edges and corner of forms.
 - 3. Smooth steel trowel finish.
 - 4. Extend 3-inches minimum indoors beyond perimeter of equipment unless otherwise shown.
 - 5. 6-inch x 6-inch #8 wire reinforcement mesh.

3.6 OBSTRUCTIONS

- A. The drawings indicate certain information pertaining to surface and subsurface obstructions, which has been taken from available drawings. Such information is not guaranteed, however, as to accuracy of location or complete information.
 - 1. Before any cutting or trenching operations are begun, verify with Owner's representative, utility companies, municipalities, and other interested parties that all available information has been provided.
 - 2. Should obstruction be encountered, whether shown or not, alter routing of new work, reroute existing lines, remove obstruction where permitted, or otherwise perform whatever work is necessary to satisfy the purpose of the new work and leave existing services and structures in a satisfactory and serviceable condition.
- B. Assume total responsibility for and repair any damage to existing utilities or construction, whether or not such existing facilities are shown.

3.7 VANDAL RESISTANT DEVICES

- A. Where vandal resistant screws or bolts are employed on the project, deliver to the Owner 2 suitable tools for use with each type of fastener used, and 25 percent spare fasteners.
- B. Proof of delivery of these items to the Owner shall be included in the Operating and Maintenance Manuals.

3.8 PROTECTION

- A. Protect work, equipment, fixtures, and materials. At work completion, work must be clean and in original manufacturer's condition.
- B. Do not deliver equipment to this project site until progress of construction has reached the stage where equipment is actually needed or until building is closed in enough to protect the equipment from weather. Equipment allowed to stand in the weather shall be rejected, and the contractor is obligated to furnish new equipment of a like kind at no additional cost to the Owner.

3.9 COORDINATION OF BRANCH CIRCUIT OVERCURRENT AND PROTECTION DEVICES

- A. Review with equipment specified which requires electrical connections. Review equipment shop drawings and manufacturer's nameplate data and coordinate exact branch circuit overcurrent protective device and conductors with equipment provided.
1. Provide equipment manufacturer's recommended overcurrent protective device indicated on nameplate at no additional cost to the Owner.
 2. If branch circuit conductors and / or conduit sizing is less than the minimum required by equipment manufacturer, notify the Architect / Engineer immediately, prior to rough-in.
 3. If equipment manufacturer is a substitution to the specified equipment manufacturer, provide the greater of the conductors specified or those required for the installed equipment manufacturer's minimum circuit conductors, at no additional cost to the Owner.
 4. If conductors indicated on plans are in excess of that permitted by equipment manufacturer, notify Architect / Engineer immediately, prior to rough-in.
 5. If conductors indicated on plans are in excess of that permitted by the equipment manufacturer, provide the maximum conductors permitted by the equipment manufacturer based on NEC ampacity tables, either in a single set, or as a set of parallel conductors as permitted by the NEC. Conductor size and quantity entering the equipment enclosures shall not exceed the equipment manufacturer's maximum recommendations.

3.10 FAULT CURRENT AND ARC FLASH STUDY FOR OVERCURRENT DEVICE COORDINATION

- A. Contractor shall provide a coordination study, fault current analysis, and Arc-Flash study report for new electrical distribution equipment downstream to the last new overcurrent device in each feeder or branch circuit, conducted and prepared by the switchgear manufacturer. The coordination study and fault current analysis shall include the manufacturer's recommendations for all adjustable overcurrent devices specified or provided. Study does not require inclusion of existing switchgear, except it shall include existing or new overcurrent devices in existing switchgear serving new switchgear. Contractor shall submit the report results prior to submitting switchgear submittals to allow changes or modifications to equipment selection.
- B. Contractor shall adjust all overcurrent device settings based on manufacturer's recommendations, or as directed by Owner / Architect at no additional cost to Owner. Settings for GFI shall be set at maximum as permitted by the NEC.
- C. Arc-Flash & Shock-Hazard Warning Labels: Provide arc-flash and shock hazard-warning labels that comply with ANSI Z535.4 on switchgear, switchboards, transformers, motor control centers, panelboards, motor controllers, safety switches, industrial control panels and other equipment that is likely to require examination, adjustment, servicing, or maintenance while energized. Locate the marking to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment. On renovation projects, install arc-flash warning labels on existing equipment where lock-out / tag-out will be required for the renovation work. Provide the information listed below on each label. Specify that arc-flash warning label information be produced by the electrical equipment manufacturer or supplier as a part of the final power system studies to be submitted by the Contractor in accordance with the electrical acceptance testing.
1. Note: In addition to the final arc-flash analysis, the final power system studies include load flow and fault-current calculations, and an overcurrent protective device (OCPD) coordination study based on the actual equipment to be installed for the project.
- D. Information to be determined and applied to electrical equipment:

1. Arc-Flash Protection Boundary
2. Arc-Flash incident energy calculated in accordance with IEEE Std 15841™
3. Working distance calculated in accordance with IEEE Std 1584a™
4. NFPA 70E Hazard / Risk Category Number or the appropriate personal protective equipment (PPE) for operations with doors closed and covers on.
 - a. Typical operations include operating circuit breakers, fused switches, and meter selector switches.
5. System phase-to-phase voltage
6. Condition(s) when a shock hazard exists (e.g. "With cover off")
7. Limited Approach Boundary as determined from NFPA 70E, Table 130.2(C)
8. Restricted Approach Boundary as determined from NFPA 70E, Table 130.2(C)
9. Prohibited Approach Boundary as determined from NFPA 70E, Table 130.2(C)
10. Unique equipment designation or code (described under "Component Identification")
11. Class for insulating gloves based on system voltage (e.g., Class 00 up to 500V)
12. Voltage rating for insulated or insulating tools based on system voltage (e.g., 1000V)
13. Date that the hazard analysis was performed.
14. "Served from" circuit directory information including the serving equipment designation, location (e.g., room number), circuit number, and circuit voltage / number of phases / number of wires.
15. If applicable, the "serves" circuit directory information including the served equipment designation, location (e.g., room number), circuit number, and circuit voltage / number of phases / number of wires.
16. An abbreviated warning label may be used where it has been determined that no dangerous arc-flash hazard exists in accordance with IEEE 1584a™, paragraph 9.2.3.
17. Use a "DANGER" label where the calculated arc-flash incident energy exceeds 40 cal/cm.

- E. Submittals: Submit four copies of coordination study and certified fault current study results to the Architect for review.

3.11 EQUIPMENT BACKBOARDS

- A. Backboards: ¾ inch, fire retardant, exterior grade plywood, painted gray, both sides.
1. Provide minimum of two 4-ft. by 8-ft. sheets of plywood for each new telephone equipment terminal location.
 2. Provide minimum of two 4-ft. by 4-ft. sheets of plywood for each new data / voice / video / communications equipment location / cable TV head end equipment, or security equipment location.

3.12 TESTING

- A. The contractors for the various sub-systems shall submit proposed testing procedures for their systems, subject to review and approval and Owner acceptance. The contract will not be declared to be substantially complete until the functional operation of the subsystems have been demonstrated and verified and reports have been provided, reviewed and accepted.
- B. The project will not be declared substantially complete until the following has taken place.
1. The "As-Built" drawings have been submitted, reviewed and accepted by the Architect / Owner / Owner's Construction Representative.
 2. The building emergency lighting system and other systems including but not limited to those listed below have been tested, completed factory start-up and

programming and adjusting as required for a complete and fully operational system acceptable to the Architect and Owner.

- a. Occupancy Sensor and Lighting Controls
- b. Surge protective device equipment
- c. Overcurrent devices
- d. Motor Controllers
- e. Emergency Lighting

3.13 LOAD BALANCING

- A. Balance the loads on each low-voltage feeder so that the voltage on each phase is within +/- 1.0% of the average voltage of the three phases. Refer to the DOE Office of Industrial Technologies, "Motor Tip Sheet #7" dated September 2005 available for download to PDF format at no charge at:

http://www1.eere.energy.gov/industry/bestpractices/pdfs/eliminate_voltage_un_balanced_motor-systemts7.pdf

END OF SECTION 26 5000

SECTION 26 0510 - CONTRACT QUALITY CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Contract quality control including workmanship, manufacturer's instructions, mock-ups and demonstrations.

1.2 QUALITY CONTROL PROGRAM

- A. Maintain quality control over supervision, subcontractors, suppliers, manufacturers, products, services, site conditions and workmanship to produce work in accordance with contract documents. Submit a narrative outline of the Quality Control Program or Plan.

1.3 WORKMANSHIP

- A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
- B. Perform work by persons qualified to produce workmanship of specified quality. Persons performing electrical work shall be required to be licensed. There shall be on-site supervision at all times, including punch list work, with that person having a minimum of journeyman license. Helpers, apprentices shall have a minimum of apprentice license.
- C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking. Under no conditions shall material or equipment be suspended from structural bridging.
- D. Provide finishes matching approved samples; all exposed finishes shall be approved by the Architect / Engineer. Submit color samples as required.

1.4 MANUFACTURER'S INSTRUCTIONS

- A. Comply with instructions in full detail, including each step in sequence.
- B. Should instruction conflict with Contract Documents, request clarification from Architect / Engineer before proceeding.

1.5 MANUFACTURER'S CERTIFICATES

- A. When required in individual Specification Sections, submit manufacturer's certificate in duplicate, certifying that products meet or exceed specified requirements.

1.6 MANUFACTURER'S FIELD SERVICES

- A. When required in individual Specification Sections, manufacturer shall provide manufacturer's qualified personnel to observe:
 - 1. Field conditions
 - 2. Condition of installation
 - 3. Quality of workmanship
 - 4. Start-up of equipment
 - 5. Testing, adjusting, and balancing of equipment
- B. Manufacturer's qualified personnel shall make written report of observations and

recommendations to Architect / Engineer.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL

- A. Comply with recognized National rating and approval agencies as well as all codes and ordinances at the federal, state and city levels.

PART 3 - EXECUTION

3.1 ADJUSTMENTS AND MODIFICATIONS

- A. Contractor shall provide all adjustments and modifications as requested by the manufacturer's qualified personnel at no additional cost to Owner.
- B. Coordination Drawings:
 - 1. Electrical room size and location required and to scale
 - 2. Equipment and accessories, switchgear and piping
 - 3. Indicate clearances and service access.

3.2 ELECTRICAL ACCEPTANCE TESTING

- A. Perform electrical acceptance testing and inspections in accordance with the current edition of the International Electrical Testing Association (NETA), *Acceptance Testing Specification (ATS)*.
- B. Perform acceptance testing, inspection, function tests, and calibration to assure that installed electrical systems and components, both Contractor and user-supplied are:
 - 1. Installed in accordance with design documents and manufacturer's instructions.
 - 2. Tested and inspected in accordance with applicable codes and standards (e.g. NFPA 110 and NFPA 111).
 - 3. Ready to be energized.
 - 4. Operational within industry and manufacturer's tolerances.

3.3 INSPECTIONS BY LOCAL AUTHORITY HAVING JURISDICTION (AHJ)

- A. Contractor shall notify design prime consultant and associated Architect / Owner's Construction Manager when he requests an inspection by the AHJ.

END OF SECTION 26 0510

SECTION 26 0512 - SHOP DRAWINGS, COORDINATION DRAWINGS & PRODUCT DATA

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Prepare submittals as required by Division 1 and as outlined below.
- B. Submit product data shop drawings only for the following and for items specifically requested elsewhere in the Contract Drawings and Specifications. Architect / Engineer reserves the right to refuse shop drawings not requested for review and to imply that materials shall be provided as specified without exception.
- C. The term submittal, as used herein, refers to all:
 - 1. Shop Drawings
 - 2. Coordination Drawings
 - 3. Product data
- D. Submittals shall be prepared and produced for:
 - 1. Distribution as specified
 - 2. Inclusion in the Operating and Maintenance Manual, as specified, in the related section

1.2 ARCHITECT / ENGINEER REVIEW OF IDENTIFIED SUBMITTALS

- A. The Architect / Engineer will:
 - 1. Review identified submittals with reasonable promptness and in accordance with schedule. Specific equipment submittals that may be required to be expedited shall be submitted separately without other submittal items not requiring the same prompt attention.
 - 2. Affix stamp and initials or signature, and indicate requirements for resubmittal or approval of submittal
 - 3. Return submittals to Contractor for distribution or for resubmission
- B. Review of submittals will not extend to design data reflected in submittals that is peculiarly within the special expertise of the Contractor or any party dealing directly with the Contractor.
- C. Architect / Engineer's review is only for conformance with the design concept of the project and for compliance with the information given in the contract.
 - 1. The review shall not extend to means, methods, sequences, techniques or procedures of construction or to safety precautions or programs incident thereto.
 - 2. The review shall not extend to review of quantities, dimensions, weights or gauges, fabrication processes or coordination with the work of other trades.
- D. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

1.3 SUBSTITUTIONS

- A. Do not make requests for substitution employing the procedures of this Section.
- B. The procedure for making a formal request for substitution is specified in Division 1.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 SPECIFICATION COMPLIANCE REVIEW

- A. Mark up a complete copy of the specification section for the product to indicate a) acknowledgement of the specification requirement (Comply), or b) acknowledgement that the particular specification requirement does not apply to this specific project (Not Applicable) or, c) acknowledgement that the specification requirement cannot be made or that a variance is being submitted for review to the Architect / Engineer / Owner (Does Not Comply, Explanation:.) Do not submit an outline form of compliance, submit a complete copy with the product data.

3.2 COMPOSITE COORDINATION DRAWINGS

- A. Produce a set of composite coordinate drawings for review and comment within four (4) weeks of receipt of Owner's official Notice to Proceed. Show coordination of structural and architectural elements with HVAC piping, ductwork, mechanical equipment, electrical conduit, low voltage systems cabling, lighting, electrical switchgear and panels, security and CCTV systems, domestic water piping, roof drains and storm sewer piping, sanitary sewer piping and fire sprinkler piping and a composite above-ceiling plan, below slab coordination drawings, and a composite mechanical and electrical equipment room floor plan.
1. Prepare the composite plans at one-quarter inch (1/4") equals one-foot scale. Include larger scale sections with vertical elevations of elements as required to confirm coordinate of all elements.
 2. For each room containing major electrical switchgear and each outside equipment area with major electrical switchgear and other equipment also include NEC working space, NEC equipment space, and NEC access to NEC working space, and housekeeping pad location and dimensions.
 3. Prepare coordination drawings to coordinate installations for efficient use of available space allowing for future additional equipment wherever possible, for proper sequence of installation, and to resolve conflicts. Coordinate with work specified in other sections and other divisions of the specifications.
 4. Identify field dimensions. Show relation to adjacent or critical features of work or products.
- B. Submit composite coordination shop drawings in plan, elevation and sections, showing receptacles, outlets, electrical and telecommunication devices in casework, cabinetwork and built-in furniture.
1. Verify location of wiring devices and outlets, communication devices and outlets, safety and security devices, and other work specified in this Division.
 2. Coordinate with drawing details, site conditions, composite coordination drawings, and millwork other equipment shop drawings prior to installation.
 3. Submit coordination and shop drawings prior to rough-in and fabrication.

3.3 EQUIPMENT SHOP DRAWINGS AND PRODUCT DATA

- A. Submittals shall not be combined or bound together with any other material submittal.
- B. Submittal Specification Information:
1. Every submittal document shall bear the following information as used in the project manual:
 - a. The related specification section number
 - b. The exact specification section title
 2. Submittals delivered to the Architect / Engineer without the specified information will not be processed. The Contractor shall bear the risk of all delays, as if no

submittal had been delivered.

- C. All product options specified shall be indicated on the product data submittal. All options listed on the standard product printed data not clearly identified as not part of the product data submitted shall become part of the Contract and shall be provided.
- D. Mark each copy of standard printed data to identify pertinent products, referenced to specification section and article number.
- E. Show reference standards, performance characteristics and capacities; wiring and piping diagrams and controls; component parts; finishes; dimensions and required clearances.
- F. Modify manufacturer's standard schematic drawings and diagrams to supplement standard information and to provide information specifically applicable to the work. Delete information not applicable.
- G. Submit drawings in a clear and thorough manner. Identify details by reference to sheet and detail, schedule, or room numbers shown on Contract Drawings.
- H. Show all dimensions of each item of equipment in its to be installed assembled condition with all components assembled. Include a series of drawings of individual components as necessary for reference.
- I. Identify field dimensions; show relation to adjacent or critical features or work or products.
- J. Submit individually bound shop drawings and product data for the following when specified or provided. The Fault Current and Overcurrent Device Coordination Analysis shall be submitted prior to other switchgear.
 - 1. Fault Current and Overcurrent Device Coordination Analysis. Submit this analysis three (3) weeks prior to any overcurrent device submittal to allow modifications to overcurrent device product selection submittal based on the manufacture's analysis and recommendations at no additional cost to the Owner.
 - 2. Enclosed Switches and Circuit Breakers
 - 3. Enclosed Motor Controllers
 - 4. Panelboards, load centers, and enclosures
 - 5. Wiring devices
 - 6. Lighting fixtures
 - 7. Lighting Controls and Occupancy Sensors
 - 8. Surge Protection Devices
 - 9. Site Lighting Poles, Fixtures, Drivers, and Lamps
 - 10. Electrical controls and time switches
 - 11. Electrical Contactors
 - 12. RTRC and/or PVC coated galvanized steel conduit and fittings conduit and fittings

3.4 MANUFACTURERS INSTRUCTIONS

- A. Submit Manufacturer's instructions for storage, preparation, assembly, installation, start-up, adjusting, calibrating, balancing and finishing.

3.5 CONTRACTOR RESPONSIBILITIES

- A. Review submittals prior to transmittal.
- B. Determine and verify:
 - 1. Field measurements
 - 2. Field construction criteria

3. Manufacturer's catalog numbers
 4. Conformance with requirements of Contract Documents
- C. Coordinate submittals with requirements of the work and of the Contract Documents.
- D. Notify the Architect / Engineer in writing at time of submission of any deviations in the submittals from requirements of the Contract Documents.
- E. Do not fabricate products, or begin work for which submittals are specified, until such submittals have been produced and bear contractor's stamp. Do not fabricate products or begin work scheduled to have submittals reviewed until return of reviewed submittals with Architect / Engineer's acceptance.
- F. Contractor's responsibility for errors and omissions in submittals is not relieved whether Architect / Engineer reviews submittals or not.
- G. Contractor's responsibility for deviations in submittals from requirements of Contract Documents is not relieved whether Architect / Engineer reviews submittals or not, unless Architect / Engineer gives written acceptance of the specific deviations identified by the Contractor on reviewed documents.
- H. Submittals shall show sufficient data to indicate complete compliance with Contract Documents:
1. Proper sizes and capacities
 2. That the item will fit in the available space in a manner that will allow proper service
 3. Construction methods, materials and finishes
- I. Schedule submissions at least 15 days before date reviewed submittals will be needed by the Contractor for processing or for making corrections for re-submittal.
- J. Contractor's Stamp of Approval
1. Contractor shall stamp and sign each document certifying to the review of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of Contract Documents.
 2. Contractor's stamp of approval on any submittal shall constitute a representation to Owner and Architect / Engineer that Contractor has either determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data or assumes full responsibility for doing so, and that Contractor has reviewed or coordinated each submittal with the requirements of the work and the Contract Documents.
 3. Do not deliver any submittals to the Architect / Engineer that do not bear the Contractor's stamp of approval and signature.
 4. Submittals delivered to the Architect / Engineer without Contractor's stamp of approval and signature will not be processed. The Contractor shall bear the risk of all delays, as if no submittal had been delivered.

3.6 SUBMISSION REQUIREMENTS

- A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Project or in the work of any other Contractor. Product and equipment related to site work or other trades which require extensive rough-in, foundations, or structural support shall be submitted as soon as possible after given notice to proceed with construction.

- B. Number of submittals required:
 - 1. Shop Drawings and Coordination Drawings: Submit one electronic data file (pdf) and three opaque reproductions.
 - 2. Product Data: Submit the number of copies the contractor requires, plus those to be retained by the Architect / Engineer, and/or electronic data (pdf) files.

- C. Accompany submittals with transmittal letter, in duplicate, containing:
 - 1. Date
 - 2. Project title and number
 - 3. Contractor's name, address and telephone number
 - 4. The number of each Shop Drawing, Project Datum and Sample submitted
 - 5. Other pertinent data

- D. Submittals shall include:
 - 1. The date of submission
 - 2. The project title and number
 - 3. Contract Identification
 - 4. The names of:
 - a. Contractor
 - b. Subcontractor
 - c. Supplier
 - d. Manufacturer
 - 5. Identification of the product
 - 6. Field dimensions, clearly identified as such
 - 7. Relation to adjacent or critical features of the work or materials
 - 8. Applicable standards, such as ASTM or federal specifications numbers
 - 9. Identification of deviations from contract documents
 - 10. Suitable blank space for General Contractor and Architect / Engineer stamps
 - 11. Contractor's signed and dated Stamp of Approval

- E. Coordinate submittals into logical groupings to facilitate interrelation of the several items.
 - 1. Finishes which involve Architect / Engineer selection of colors, textures or patterns
 - 2. Associated items requiring correlation for efficient function or for installation

3.7 RESUBMISSION REQUIREMENTS

- A. Make resubmittals under procedures specified for initial submittals. Re-submittals shall be a complete submittal as if it were the initial submittal unless otherwise instructed in the review comments on the original submittal.
 - 1. Indicate that the document or sample is a resubmittal
 - 2. Identify changes made since previous submittals

- B. Indicate any changes which have been made other than those requested by the Architect / Engineer.

END OF SECTION 26 0512

SECTION 26 0516 - EXCAVATING, BACKFILLING AND COMPACTING FOR ELECTRICAL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 apply to this section.
- B. Refer to Instructions for substitution of materials and products.
- C. Addenda issued during the bidding period that affect this section of the specifications.

1.2 WORK INCLUDED

- A. Coordinating all excavating and backfilling for the electrical underground, and all related appurtenances. Provide concrete duct banks as specified in other related Division 26 specification sections.
- B. The extent of raceways, excavation, and backfill shall be in conformance with the locations, raceways, elevations and grades shown on the drawings.

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM) Use current edition.
 - 1. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)
 - 2. ASTM D1556, Standard Test method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
 - 3. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
 - 4. ASTM D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- B. Local Authority Having Jurisdiction Standards
- C. Local Governing Agencies or Utilities

1.4 WARRANTY

- A. Provide written warranty against defects in the material and workmanship for the work of this Section for a period of one year from the Date of Substantial Completion of the Project. Refer to Division 1 for Warranty form.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Concrete: Refer to other Division 26 specification section where concrete encasement is required or specified.
- B. Cement-Stabilized Sand: Clean, local sand mixed with not less than 1-1/2 sacks of Portland cement per ton; mix in a mill-type mixer.
- C. Sand: Clean, local sand

- D. Earth Backfill: Clean local material consistent with the surrounding earth material and free of large clods, roots, organic materials, rocks or other debris.

PART 3 – EXECUTION

3.1 EXCAVATION

- A. General:
1. All utility trenches shall be constructed in conformance with OSHA trench safety standards.
 2. Refer to project Geotechnical Report for additional requirements for excavating and backfilling of utility trenches.
 3. Sheet piling and shoring shall be accomplished to the extent necessary to maintain the sides of the trench in a vertical position throughout the construction period for trenches five feet in depth or deeper. Where approved, trench sides may be laid back in lieu of shoring to meet OSHA safety standards.
 4. Utilities shall not be constructed or laid in a trench in the presence of water. All water shall be sufficiently removed from the trench prior to the raceway placing operation to ensure a dry, firm bed on which to place the raceway.
- B. Appurtenances:
1. Any overdepth excavation below appurtenances shall be refilled with cement-stabilized sand.
- C. Electrical Trenches:
1. Electrical underground raceways must be the minimum depth required by the local governing authority and Power Company.
 2. Trench width for the electrical raceway shall be a minimum of the outside raceway encasement plus 12 inches.
 3. Trenches shall be excavated to a depth of at least 6 inches below the conduit raceway. The conduit raceway bedding or concrete encasement shall then be placed in accordance with the specifications, local governing authority, and Power Company standard details.

3.2 BEDDING AND BACKFILL

- A. Electrical Trenches:
1. Place backfill, consisting of sand or cement stabilized sand, to a depth of one foot above top of raceway or concrete duct bank and compact to 90% maximum density.
 2. Backfill the remainder of the trench in 6 inch lifts with select excavated material and compact as required to achieve density of soil of surrounding area.
- B. Utility Locators:
1. Provide metallic locators for utility company raceways as required by respective utility.
 2. Refer to other specification sections for additional requirements for underground raceway locators and markers.

END OF SECTION 26 0516

SECTION 26 0519 - CONDUCTORS AND CONNECTORS – 600 VOLT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide electrical conductors, wire and connector work as shown, and specified.
- B. Types: The types of conductors and connectors required for the project include the following:
 - 1. 600V building conductors
 - 2. 600V building conductor connectors
- C. Application: The applications for conductors and connectors required on the project are as follows:
 - 1. Power distribution circuitry
 - 2. Lighting branch circuitry
 - 3. Appliance, receptacle, and equipment branch circuitry
 - 4. Motor branch circuitry
 - 5. Control wiring
 - 6. Line voltage
- D. Refer to other specific specification sections for voice, video, data, alarm and instrumentation cables.

1.2 QUALITY ASSURANCE

- A. UL Label: Conductors and connectors shall be UL labeled.

1.3 REFERENCES

- A. Refer to other specific specification sections regarding specialized wiring and connections.

PART 2 – PRODUCTS – Provide products manufactured in the USA

2.1 CONDUCTORS AND CONNECTORS

- A. General: Except as indicated, provide conductors and connectors of manufacturer's standard materials, as indicated by published product information, designed and constructed as instructed by the manufacturer, and as required for the installation.
- B. Conductors: Provide factory-fabricated conductors of the size, rating, material, and type as indicated for each use. Conductors shall be soft or annealed copper wires meeting, before stranding, the requirements of ASTM B 3, Standard Specification for Soft or Annealed Copper Wire for Electrical Purposes, latest edition.
 - 1. Conductors for control wiring sized #14 AWG through #10 AWG shall be stranded.
 - 2. Conductors for power and lighting shall be stranded. Stranding shall be Class B meeting the requirements of ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft.
- C. Insulation for standard building conductors: Insulation shall meet or exceed the requirements of UL 83, Standard for Thermoplastic Insulated Wires.
 - 1. All wiring inside lighting fixtures shall be temperature rated per NEC.
 - 2. Insulation for copper conductors shall be UL Type THHN/THWN, 90 degrees C.

- D. Cable Lubricant: Fire resistant, nonflammable, water-based type for standard building conductors. Provide cable lubricants for fire rated cables as recommended by the cable manufacturer.

2.2 COLOR CODES FOR CONDUCTORS FOR BRANCH CIRCUITS AND FEEDERS

- A. Color coding for conductors as required by NEC 210.5. Color coding for phase and voltage shall be as required by local codes and local standards. Where such standards do not exist, color coding shall be as follows:

Color Code Table	USE CONTINUOUS COLOR CODED INSULATION THROUGHOUT					
System/Phase	A	B	C	N	G	IG
120/208 3 Ph	Black	Red	Blue	White	Green	Green/Yellow Stripe
120/240 3 Ph	Black	Orange	Blue	White	Green	Green/Yellow Stripe
120/240 1 Ph	Black	N/A	Blue			
277/480	Brown	Purple	Yellow	Gray	Green	Green/Yellow Stripe

Notes to Color Code Table:

1. 120/208, 120/240, and 277/480 Volt Systems shall be routed in separate raceways.
2. Switched legs of phase conductors for lighting and appliance branch circuits shall be of the same color as described above throughout the entire circuit.
3. Conductors shall be the same color from breaker to device or outlet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install electrical conductors and connectors as shown, in accordance with the manufacturer's written instructions, the requirements of NEC, the NECA Standard of Installation, and industry practices.
- B. Coordination: Coordinate conductor installation work with electrical raceway and equipment installation work, as necessary for interface.
- C. Conductors:
1. Provide a grounded (neutral) conductor for each branch circuit. Do not share grounded (neutral) conductors.
 2. No more than six phase conductors shall be installed in a single raceway. Any combination of phase conductors and grounded (neutral) conductors in any raceway shall not exceed nine.
 3. When any combination of four or more phase and grounded (neutral) conductors are installed in a raceway, the minimum size for all conductors including equipment ground conductor shall be #10 AWG, and they shall be de-rated accordingly.
 4. When more than four (4) conductors are size #10 AWG, they shall be installed in a one-inch conduit.

5. Pull conductors together when more than one is being installed in a raceway. Whenever possible, pull conductors into their respective conduits by hand. Use pulling lubricant when necessary.
6. Before any conductor is pulled into any conduit, thoroughly swab the conduit to remove foreign material and to permit the wire to be pulled into a clean, dry conduit.
7. Run feeders their entire length in continuous section without joints or splices.
8. No wire smaller than #12 AWG shall be permitted for any lighting or power circuit. No wire smaller than #14 AWG shall be used for any control circuit, unless shown otherwise.
9. Provide the same size wire from the panelboard to last outlet on circuit. For 20 amp branch circuits operating at 150V or less, provide #10 AWG wire when the first outlet is over 75-feet from the panelboard. For branch circuits operating at 150 to 600 volts, provide #10 AWG wire when the first outlet is over 150-feet from the panelboard.
10. Branch circuit voltage drop shall not exceed 3% of rated voltage.
 - a. Total voltage drop from the point of service to the last outlet or utilization equipment of the same voltage shall not exceed five-percent of rated voltage.
 - b. Total voltage drop from the point of service to transformers with adjustable taps, buck-boost transformers, uninterruptible power supplies (UPS), or voltage regulators shall not exceed five-percent of rated voltage.
 - c. Total voltage drop from a separately derived system, transformer with adjustable taps, buck-boost transformer, uninterruptible power supply (UPS), or voltage regulator to the last outlet or utilization equipment of the same voltage shall not exceed five-percent of rated voltage.
 - d. Total voltage drop from the point of service to distribution equipment of the same voltage shall not exceed two-percent of rated voltage.
 - e. Branch circuit voltage drop from distribution equipment to the last outlet or utilization equipment shall not exceed three-percent of rated voltage.
 - f. Provide the same size branch circuit conductors to last outlet on circuit unless specifically noted or indicated otherwise on the drawings. For 20 amp branch circuits operating at 150-Volts or less, provide #10 AWG wire when the first outlet is over 75-feet from the panelboard. For branch circuits operating above 150-Volts to 600-Volts, provide #10 AWG wire when the first outlet is over 150-feet from the panelboard.
11. No tap or splice shall be made in any conductor except in outlet boxes, pull boxes, junction boxes, splice boxes, or other accessible locations. Make taps and splices using an approved compression connector. Insulate taps and splices equal to the adjoining conductor. Make splices or taps only on conductors that are a component part of a single circuit, protected by approved methods. Taps or splices in feed through branch circuits for connection to light switches or receptacles shall be made by pigtail connection to the device.
12. Support conductors in vertical raceways, as required by the NEC.
13. Do not permit conductors entering or leaving a junction or pull box to deflect to create pressure on the conductor insulation.
14. Make joints in branch circuits only where circuits divide. These shall consist of one through circuit to which the branch from the circuit shall be spliced.
15. Make connections in conductors up to a maximum of one #6 AWG wire with two #8 AWG wires using twist-on pressure connectors of required size.
16. Make connections in conductors or combinations of conductors larger than specified using cable fittings of type and size required for specific duty.
17. After a splice is made, insulate entire assembly with UL-approved insulating tape to a value equivalent to the adjacent insulation.

18. Make splices and connections in control circuit conductors using UL-approved solderless crimp connectors.
 19. All conduits shall be installed with an insulated grounding conductor per NEC 250.122. Where green conductor insulation is not available, the ground conductor shall be identified with green phasing tape at all accessible locations.
 20. Neatly train and lace wiring inside boxes, equipment and panelboards. Provide tie-straps around conductors with their shared neutral conductor where there are more than two neutral conductors in a conduit.
 21. Clean conductor surfaces before installing lugs and connectors.
 22. Make splices, taps and terminations to carry full ampacity of conductors with no perceptible temperature rise.
 23. Provide stranded conductors connected with pressure type connectors / compression fittings and terminal lugs UL listed for the type of conductor used (AL-CU) and correctly sized to the diameter of the bare conductors.
 24. Run mains and feeders their entire length in continuous pieces without splices or joints.
 25. Color code conductors.
 26. Do not install a pull string in conduits containing conductors.
 27. Conductors shall be the same color from load side of overcurrent protection device to outlet or utilization equipment.
 28. Spare conductors shall not be installed in any conduit, gutter, raceway, panel or enclosure unless noted otherwise.
- D. Identification: Label each phase conductor in each junction box with corresponding circuit number, using self-adhesive wire markers.
- E. Splices and Joints:
1. In accordance with UL 486A, C, D, E, and NEC.
 2. Aboveground Circuits (No. 10 AWG and smaller):
 - a. Connectors: Solderless, screw-on, reusable pressure cable type, rated 600 V, 220° F, with integral insulation, approved for copper and aluminum conductors.
 - b. The integral insulator shall have a skirt to completely cover the stripped wires.
 - c. The number, size, and combination of conductors, as listed on the manufacturers' packaging, shall be strictly followed.
 3. Motor connections:
 - a. All AHU motors connections shall be split bolt connectors.
 - b. All non-AHU motors 10 HP and larger shall be split bolt connectors.
 - c. All non-AHU motors less than 10 HP shall be split bolt connectors or as recommended by the manufacturer.
- F. Aboveground Circuits (No. 8 AWG and larger):
1. Connectors shall be indent, hex screw, or bolt clamp type of high conductivity and corrosion resistant material, listed for use with copper and aluminum conductors.
 2. Provide field-installed compression connectors for cable sizes 250 kcmil and larger with not less than two clamping elements or compression indents per wire.
 3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Splice and joint insulation level shall be not less than the insulation level of the conductors being joined.
 4. Plastic electrical insulating tape: Per ASTM D2304, flame-retardant, cold and weather resistant.
- G. Underground Branch Circuits and Feeders:
1. Submersible connectors in accordance with UL 486D, rated 600 V, 190°F, with integral insulation.

3.2 TESTING

- A. Pre-Energization Check: Before energizing, check cable and conductors for circuit continuity and short circuits. Correct malfunctions.
- B. Service Entrance and Feeder Insulation Resistance Test: Each main service entrance conductor and each feeder conductor shall have its insulation resistance tested after the installation is complete except for connection at its source and point of termination. Testing shall be performed by qualified technicians who have been trained in testing procedures and in the use of all test equipment.
1. Make tests using a Biddle Megger or equivalent test instrument at a voltage of not less than 1000 VDC; measure resistance from conductor to conductor, conductor to neutral (if present) and from conductor to ground. Insulation resistance shall not be less than the following:
- | Wire Size (AWG) | Insulation Resistance (Ohms) |
|------------------|------------------------------|
| #8 | 250 K |
| #6 through #2 | 100 K |
| #1 through #4/0 | 50 K |
| Larger than #4/0 | 25 K |
2. Conductors that do not meet or exceed the insulation resistance values listed above shall be removed, replaced, and retested.
- C. Submittals: Contractor shall furnish instruments and personnel required for tests. Submit 4 copies of certified test results to Architect for review. Test reports shall include conductor tested, date and time of test, relative humidity, temperature, and weather conditions.
- D. Voltage and Current Values: The voltage and current in each conductor shall be measured and recorded after connections have been made and the conductor is under load.

SAMPLE DC HIGH VOLTAGE CABLE TEST REPORT
 (Specification Paragraph 3.2, C)

Date _____

Contract and Work Location: ____
 Contract (Project) No.: _
 Circuit Identification: ____
 (Dwg., Title, Number and Ckt. Number)

Test Equipment: _____
 (Make, Model, Serial No., Etc.)
 Applied Test Voltage _____
 Normal Oper. Voltage _____
 Cable Installation: New _____ Used _____
 (Date) (No. Years)
 Cable Size _____ AWG
 Cable Length _____ Ft.
 Cable Material _____ Cu _____ Al
 Temperature _____ Humidity _____

TEST DATA - RESISTANCE IN KILO OHMS

CONDUCTOR PER PHASE	A-N	B-N	C-N	A-G	B-G	C-G	A-B	B-C	A-C

END OF SECTION 26 0519

SECTION 26 0526 - ELECTRICAL GROUNDING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Grounding shall conform to the requirements of:
 - 1. National Electrical Code.
 - 2. Governing local codes.
 - 3. All Local Utility Companies
- B. Ground effectively and permanently.
 - 1. Neutral conductor at the main service disconnect and other separately derived systems.
 - 2. All conduit systems.
 - 3. All electrical equipment and related current carrying supports or structures.
 - 4. All metal piping systems.
 - 5. All building structural metal frames.
 - 6. All telephone/voice/video/CATV/data utilities

1.2 REFERENCE STANDARDS

- A. ANSI/IEEE Standard 142 - "Recommended Practice for Grounding of Industrial and Commercial Power Systems."
- B. ANSI/UL 467 - "Safety Standard for Grounding and Bonding Equipment."
- C. Article 250 of the NEC (NFPA 70) for grounding.
- D. NECA – Standard of Installation
- E. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems
- F. EIA / TIA 607

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Copperweld
- B. nVent ERICO
- C. Burndy
- D. O. Z Gedney
- E. Eaton

2.2 GROUNDING ELECTRODES

- A. Driven Rod Electrode
 - 1. 3/4" x 10'-0" copper clad grounding electrode.
 - 2. UL listed.
 - 3. Approved thermal fusion connector methods (exothermic).

B. Metal frame of building or enclosure.

C. Foundation concrete encased rebar.

2.3 EXOTHERMIC CONNECTIONS

A. Exothermic type for underground and structural steel; Cadweld

B. Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.4 WIRE

A. Stranded, copper cable

B. Foundation Electrodes: 4/0 AWG

C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements

PART 3 - EXECUTION

3.1 GROUNDING AND BONDING

- A. In the service equipment, provide a separate (dedicated) ground bus.
1. Bond the ground bus with copper bus bar or cable, of equal or greater current carrying capacity of the service grounding conductor, to the neutral bar.
 2. Resistance of neutral to ground shall not exceed 10 Ohms.
 3. Connect the electric service grounding electrode conductors to the incoming metal water pipe system (when available, using a suitable ground clamp) and to a supplemental electrode such as a ground rod or ground loop.
 4. Provide grounding and bonding at the power company's metering equipment.
 5. Provide access and cover for access to the ground grid and removable connections for testing the system.
- B. Connect the grounding electrode conductor between the ground bus and the grounding electrode system.
1. In rigid PVC conduit.
 2. Provide thermo fusion connection for each rod ground electrode.
 - a. All rod electrodes shall be located outside the building in non-paved areas where available. Access cover top shall be flush with finish grade or floor.
 - b. Install rod electrodes as required. Install additional rod electrodes as required to achieve specified resistance to ground.
 - c. The minimum distance between driven ground rod electrodes shall be 10'.
 3. The total ground resistance shall not exceed 10 Ohms for service entrance grounds and 25 Ohms for equipment grounds.
 - a. Where this condition cannot be obtained with one electrode, install a longer electrode, deep-driven sectional electrodes, or additional grounding electrodes until the required ground resistance is obtained.
- C. Provide an insulated equipment grounding conductor inside all conduits, raceways, surface raceways, gutters and wireways. The ground wire shall be bonded to each box to suitable lug, bus, or bushing. All bonding jumpers shall be routed inside conduit or raceway.

- D. Provide an insulated isolated equipment grounding conductor in addition to the insulated equipment grounding conductor for all isolated grounding feeders, branch circuits, outlets and isolated grounding receptacles.
- E. Provide all conduit terminating in switchgear, transformers, switchboards, panelboards and voice/data outlets with grounding bushings, where required, and ground wire extended to ground bus in equipment. Install grounding bushings where reducing washers are used and concentric and eccentric knock-outs are used.
- F. Main bus and building grounding electrode conductor installation shall be witnessed by the Architect / Engineer.
- G. Provide bonding to meet Regulatory Requirements.
- H. Interface with lightning protection system when lightning protection system is specified.
- I. Locate and install anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- J. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
- K. Do not use spring steel clips and clamps.
- L. Do not use powder-actuated anchors.
- M. Do not drill or cut structural members.
- N. Do not use compression or mechanical connectors underground.
- O. Do not use sheetmetal or self-drilling screws for bonding connections. Provide listed or approved connectors.
- P. Provide grounding access well for each driven ground electrode, not located in manholes or pull boxes.
 - 1. Access well top shall be flush with finish paved surfaces.
 - 2. Ground access wells located in non-paved areas shall be set two-inches above surrounding finished grade. Provide 12-inch wide by 8-inch deep reinforced concrete crown around neck or opening and sloped down away from pull box opening.
 - 3. Provide thermal fusion (exothermic) connectors approved for direct burial.

3.2 METAL FRAME OF BUILDING OR STRUCTURE

- A. Effectively ground the building steel or structure per NEC 250-52 (2).

3.3 UFER GROUND

- A. Provide a UFER ground at bottom of building slab per NEC 250.52 (3), bond to building steel.

3.4 MISCELLANEOUS REQUIREMENTS

- A. Continuity of the equipment grounding system shall be maintained throughout the project. Equipment grounding jumpers shall be installed across conduit expansion fittings, liquid-tight flexible metal and flexible metal conduit, and other non-electrically continuous

raceway fittings.

- B. Equipment grounding conductors and grounding electrode conductor shall be stranded copper conductors and run in a suitable raceway. Grounding conductors and grounding electrode conductor shall be continuous, without joints or splices over their entire length, except as allowed by NFPA 70/NEC.
- C. For separately derived alternating current system grounds, bond the case and neutral of each transformer secondary winding directly to the nearest available effectively grounded structural metal member as required in NEC 250.
- D. Exterior Electrical Equipment Racks:
 - 1. Provide driven ground electrode.
- E. Technology/Data/Voice Communications, CATV, CCTV, and MATV Equipment Grounding: Provide grounding electrode conductor from the communications service equipment to the building grounding system as required. Grounding shall conform to ANSI/TIA/EIA 607(A) – Commercial Building Grounding and Bonding Requirements for Telecommunications, National Electrical Code®, ANSI/NECA/BICSI-568 and manufacturer's grounding requirements as minimum. Bonding shall be of low impedance to assure electrical continuity between bonded elements.
 - 1. Bond each equipment rack, cabinets, frames, together and with #6 AWG insulated ground conductor to the local TMGB / TGB. Bond and ground equipment racks, housings, messenger cables, raceways, and rack-mounted conduit.
 - 2. All conduits terminating to cable trays, wireways, and racks shall be mechanically fastened. When connected to a cable tray or rack, it must be connected with ground bushings, wire bonded to the tray or rack, and grounded to the main building grounding system or IDF room grounding bar using #6 AWG copper.
- F. Ground lighting fixture bodies to the conduit grounding system.
- G. Bond receptacle ground to the box and conduit ground system, except where and insulated/isolated grounding receptacle or outlet is specified.
- H. Ground connections to building steel, grounding electrodes and all underground connections shall be by thermal fusion (exothermic).
- I. Provide OZ Type "BJ" bonding jumper at all expansion joints, points of electrical discontinuity or connections in conduit where firm mechanical bond is not possible, such as flexible connections, insulating couplings, etc.
- J. Ground each lighting and power panelboard by connecting the grounding conductors to the grounding stud.
- K. Ground each secondary dry-type transformer to the ground bus of the primary side panelboard. Provide a bonding jumper between the ground stud and the neutral. Ground transformer ground stud to ground loop if a ground loop is installed or the nearest structural steel member.
- L. Bond every item of equipment served by the electrical system to the building equipment ground system. This includes, but is not limited to, switchboards, panelboards, disconnect switches, receptacles, cable trays, controls, fans, air handling units, pumps and flexible duct connections.
- M. Ground each light pole, power distribution poles, and metal conduit stub-ups at each light

pole base.

- N. Ground all metal conduit including metal conduit used for bends and penetrations through concrete.
- O. Bond hot water and cold water piping together at each domestic water heater.

3.6 MANHOLE AND/OR PULL BOX GROUNDING

- A. Provide a driven ground rod and ground bond loop in each power and telephone manhole or pull box. Bond cable racks and medium voltage cable shields at splices and terminations, ductbank conduit ground bushings and all other metal components in manholes or pull box to the ground loop.

3.7 COORDINATION

- A. General: Coordinate installation of grounding connections for equipment with equipment installation work.

3.8 TESTING

- A. Ground Resistance Test: Perform a ground resistance test for comparison to future inspection and testing data by the Owner. Test shall be performed using a Biddle Megger Earth Tester or equivalent test instrument. The test shall not be performed within 48 hours after the last rainfall.
 - 1. Inspect and test in accordance with NETA ATS except Section 4
 - 2. Grounding and Bonding: Perform inspections and tests listed in NETA ATS, Section 7.13
- B. True Root Mean Square (RMS) AC measurements: The True RMS AC Measure test should be performed for all bonding conductors. The recommended maximum AC current value on any bonding conductor should be less than 1 ampere (A). The recommended maximum DC current value should be less than 500 milliamperes (mA). If abnormally high AC current levels are present on any bonding conductor, a dangerous faulty wiring condition likely exists within the room.
- C. Two-Point Bonding Measurements: The Two-point Bonding test should be performed for all bonding conductors. This test should be performed using an earth grounding resistance tester configured for a continuity test. The test is performed by connecting the meter leads between the nearest available grounding electrode (e.g., structural steel) and the TMGB or TGB. The recommended maximum value for the bonding resistance between these two points is 0.1 Ohms (100 milliohms).
- D. Submittals: Furnish instruments and personnel required for tests. Personnel shall be trained in all aspects of testing grounding systems and shall be formally trained on using all test equipment required. Submit 2 copies of certified test results for Owner's record and submit 4 copies of certified test results to Architect / Engineer for review. Test reports shall include date and time of tests, relative humidity, temperature, and weather conditions.

END OF SECTION 26 0526

SECTION 26 0533 - CONDUIT SYSTEMS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Furnish and install a complete system of electrical conduits and fittings.

1.2 REFERENCE STANDARDS

- A. National Electrical Code
- B. Local codes and ordinances
- C. UL
- D. ETL

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS – Provide products manufactured in the USA

- A. Raceways:
 - 1. Allied, International Metal Hose, Ipex, Heritage Plastics, Wheatland, Can-Tex, Carlon, Certain-Teed, Anamet, Inc., Electri-Flex Co., Western Tube and Conduit
 - 2. PVC Coated RGC: Perma Cote or Plasti-Bond, – no exceptions
 - 3. Stainless Steel: Calbrite, Gibson
 - 4. Aluminum: American Conduit/Sapa, Wheatland, Eaton B-Line, Patriot Aluminum Products
 - 5. Reinforced Thermosetting Resin Conduit (RTRC): FRE Composites, Champion Fiberglass, United Fiberglass
- B. Fittings:
 - 1. Appleton, Crouse Hinds, Topaz, Steel City, O.Z. Gedney, Carlon, Heritage Plastics, Raco, Ipex, International Metal Hose, Lew Electric Fittings Co.
 - 2. PVC Coated ferrous fittings: Perma-cote or Plasti-Bond, – no exceptions
 - 3. Stainless Steel: Calbrite, Gibson, Crouse Hinds
 - 4. Aluminum: American Conduit/Sapa, Wheatland, Eaton B-Line, Patriot Aluminum Products
 - 5. Reinforced Thermosetting Resin Conduit (RTRC): FRE Composites, Champion Fiberglass
- C. Condulets and Conduit Bodies:
 - 1. Appleton, Form 85
 - 2. PVC Coated: Perma-cote or Plasti-Bond, – no exceptions
 - 3. Stainless Steel: Calbrite, Gibson, Crouse Hinds
 - 4. Reinforced Thermosetting Resin Conduit (RTRC): FRE Composites, Champion Fiberglass
- D. Steel MC Cable for light fixture whips:
 - 1. AFC
 - 2. Southwire
 - 3. General Cable
 - 4. Kaf-Tech

2.2 GENERAL

- A. The minimum conduit size shall be $\frac{3}{4}$ -inch unless indicated otherwise in Divisions 26, 27 or 28.
 - 1. Branch Circuits: Minimum conduit size for dedicated outlets shall be $\frac{3}{4}$ -inch. Minimum conduit size from branch circuit panel to first outlet box of a multi-outlet branch circuit shall be $\frac{3}{4}$ -inch. Minimum conduit size from first outlet box to additional outlet boxes of a multi-outlet branch circuit where the conduit is installed above accessible ceilings or inside metal stud walls shall be $\frac{1}{2}$ -inch.
 - 2. Feeder Circuits: Minimum conduit size shall be $\frac{3}{4}$ -inches.
 - 3. Technology, telecommunications, and low voltage systems: The minimum conduit size shall be $\frac{3}{4}$ -inches unless noted or indicated otherwise.
 - 4. The minimum conduit size between buildings for technology, voice, data, fire alarm, video, security, surveillance, BMCS, and other telecommunications shall be 2-inch unless indicated otherwise.
- B. The minimum conduit size for flexible metallic conduit for tap connections to individual light fixtures shall be $\frac{1}{2}$ inch, or steel metal clad (MC) cable with insulated ground conductor maximum 6 feet.
- C. Electrical nonmetallic tubing, flexible polyethylene or PVC tubing shall not be used on this project.
- D. BX and AC cable shall not be used on this project.
- E. PVC elbows shall not be used on this project.
- F. Intermediate metal conduit (IMC) shall not be used on this project.

2.3 RIGID METAL CONDUIT

- A. UL labeled, Schedule 40:
 - 1. Mild steel pipe, zinc coated inside and out
 - 2. Aluminum Alloy 6063, T-1 temper
 - 3. Threaded ends
 - 4. Insulated bushings
- B. Fittings shall meet the same requirements as rigid metal conduits.
 - 1. UL labeled
 - 2. Threaded fittings

2.4 ELECTRICAL METALLIC TUBING (EMT)

- A. UL labeled, standard weight:
 - 1. Cold rolled steel tubing, zinc coated inside and out
 - 2. Aluminum Alloy 6005, 6063. Temper T-1
- B. Fittings shall meet the same requirements as EMT conduits.
 - 1. UL labeled
 - 2. Insulated throat connectors
 - 3. Steel fittings with setscrews with lock nuts on threaded ends, no snap locks
 - 4. Cast metal fittings are not approved
 - 5. Uni-couple type connectors are not approved
 - 6. Split ring, anti-short bushings are not approved

2.5 RTRC CONDUIT FITTINGS AND CONDUIT BODIES

- A. UL listed
- B. Standard wall thickness sizes ¼-inch through 4-inch
- C. Underground medium wall thickness sizes 5 and 6-inch
- D. Conduit interface joints above grade, gasket joint below grade
- E. Extra heavy wall for above ground and/or UL Class 1 Division 2 and Class 1 Zone 2 applications.

2.6 PVC COATED RIGID STEEL WITH URETHANE INTERIOR COATING

- A. The PVC coated galvanized rigid conduit and fittings must be ETL Listed and Verified. The PVC coating must have been investigated and verified by ETL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations must be ETL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating must be UL listed for the hazard conditions to which they are to be used. All conduit and fittings must be new, unused material. Applicable UL standards may include UL 6 Standard for Safety, Rigid Metal Conduit, and UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.
- B. The PVC coated galvanized rigid conduit and fittings must be ETL Verified to the Intertek ETL SEMKO High Temperature H₂O PVC Coating Adhesion Test Procedure for 200 hours. The PVC coated galvanized rigid conduit must bear the ETL Verified PVC-001 label to signify compliance to the adhesion performance standard.
- C. The conduit shall be hot dip galvanized inside and out with hot galvanized threads.
- D. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.
- E. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.
- F. Form 8 Condulets, ½-inch through 2-inch diameters, shall have a tongue-in-groove gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 inches of mercury (vacuum) for 72 hours shall be available.
- G. Form 8 Condulets shall be supplied with plastic encapsulated stainless-steel cover screws.
- H. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable.
- I. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C).

- J. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.
- K. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.
- L. Independent certified test results shall be available to confirm coating adhesion under the following conditions
 - 1. Conduit and conduit exposure to 150°F (65°C) and 95% relative humidity with a minimum mean time to failure of 30 days. (ASTM D1151)
 - 2. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
 - 3. No trace of the internal coating shall be visible on a white cloth following six wipes over the coating which has been wetted with acetone (ASTM D1308).
 - 4. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.
- M. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All U bolts shall be provided with plastic encapsulated nuts that cover the exposed portions of the threads.
- N. All fittings, clamps, straps, struts, and hardware used with PVC coated conduit shall be PVC coated or 316 stainless steel

2.7 STEEL FLEXIBLE CONDUIT

- A. Steel flexible metallic conduit:
 - 1. Zinc coated inside and out
 - 2. 18-inches minimum length, 24-inches maximum length
- B. Steel flexible metallic conduit for tap connections to light fixtures where steel MC Cable fixture whips are not used:
 - 1. 18 inches minimum length; 6 feet maximum length
- C. Liquid tight flexible steel conduit
 - 1. Type L.A. - Grounded - UL Approved
 - 2. 18-inches minimum length, 24-inches maximum length

2.8 PVC CONDUIT

- A. UL labeled Schedule 40 and Schedule 80
- B. PVC fittings and solvent welded joints
- C. Acceptable PVC conduit manufacturer: Ipex, Cantex

2.9 CONDULETS AND CONDUIT BODIES

- A. UL Labeled
- B. Form 85
- C. PVC Coated: Form 8

- D. LBC Condulets shall be used for size 2 inch and above.
- E. LL and LR Condulets shall not be used for 2 inch and above

2.10 ROOF MOUNTED CONDUIT AND BOX SUPPORTS

- A. Conduit supports and pads suitable for direct sunlight, conduit size, weight, quantity and roof system with unistrut supports and accessories. Conduit supports shall allow for conduit expansion and contraction.
- B. Refer to roofing specifications for additional information. The limitations and restrictions contained in any roofing specification shall prevail and supercede these specifications for roof mounted supports for conduits and boxes.
- C. Approved Manufacturer:
 - 1. Portable Pipe Hangers
 - 2. Eaton B-Line
 - 3. Miro Industries, Inc.

2.11 ALUMINUM CONDUIT

- A. UL Labeled
- B. Aluminum fittings shall meet the same requirements of aluminum conduits, compatible steel fittings.
 - 1. UL Labeled for use with aluminum conduit.

2.12 STAINLESS STEEL CONDUIT

- A. UL Labeled
- B. Rigid Stainless Steel:
 - 1. Type 304 Stainless Steel
 - 2. Threaded ends
 - 3. Insulated Bushings
- C. EMT:
 - 1. Type 304 Stainless Steel
 - 2. Compression Fittings
 - 3. Insulated Bushings
- D. Fittings, elbows, nipples, strut, device box, clamps straps, etc.
 - 1. Type 304 Stainless Steel

2.13 ELECTRICAL NON-METALLIC TUBING (ENT)

- A. UL labeled Schedule 40
- B. PVC fittings and solvent welded joints
- C. Acceptable manufacture: Carlon

2.14 EXTERIOR IN-GRADE PULL BOXES

- A. Enclosures, boxes and covers are required to conform to all test provisions of the most current American Association of State Highway and Transportation Officials (AASHTO) standards for H-20 loading applications.
 - 1. AASHTO H-20 certified precast concrete, cast iron or other AASHTO recognized materials, rated for deliberate traffic.
 - 2. Conduit entry knock-outs as required
 - 3. Bolt down galvanized steel/cast iron covers
 - 4. Thin wall knocks outs as required
 - 4. Integral bottom
 - 5. Box height as required for specified conduit depth and required top elevation.
 - 6. Concrete design strength of minimum 5,500 PSI at 28-days
 - 7. Place enclosures on a minimum of 6 inches of coarse gravel with a border of 6-inches beyond the enclosures exterior dimension.
 - 8. Size and volume as required for application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install electrical conduits and fittings for all wiring of any type unless specifically specified or instructed to do otherwise. Install conduits and fittings in accordance with local codes and applicable sections of the NECA "Standard of Installation", concealed where possible.
 - 1. Fasten conduit supports to building structure and surfaces; do not support to roof deck.
 - 2. Arrange supports to prevent misalignment during wiring installation.
 - 3. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
 - 4. Do not attach conduit to ceiling support wires.
 - 5. Arrange conduit to maintain head room and present neat appearance.
 - 6. Maintain 4-inch clearance between conduit and rooftop surfaces.
 - 7. Cut conduit square using saw or pipe cutter; de-burr cut ends.
 - 8. Bring conduit to shoulder of fittings; fasten securely.
 - 9. Conduit penetrations to all individual motor controllers, VFDs, and motor control cabinets shall only be made at the bottom of the enclosure. For other equipment, provide listed water sealing conduit hubs to fasten conduit to sides or tops of electrical equipment enclosures, device box, gutter, wireway, disconnect, etc.
 - 10. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
 - 11. Ground and bond conduit as required.
 - 12. Identify conduit as required.
 - 13. Route all conduits above building slab perpendicular or parallel to building lines.
 - 14. Do not use no-thread couplings and connectors for galvanized steel, PVC coated galvanized steel, or aluminum rigid conduit.
- B. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.
- C. In areas where raceway systems are exposed and acoustical or thermal insulating material is to be installed on walls, partitions, and ceilings, raceways shall be blocked out proper distance to allow insulating material to pass without cutting or fitting. Also provide Kindorf galvanized steel channels to serve as standoffs for panels, cabinets and gutters.
- D. Securely fasten conduits, supports and boxes, to ceiling (not roof deck), walls, with Rawl Plugs or approved equal anchors. Use lead cinch anchors or pressed anchors. Use only

cadmium plated or galvanized bolts, screws. Plastic anchors and lead anchors shall not be used for overhead applications.

- E. Provide separate raceway systems for each of the following when specified, indicated or required:
1. 120/208 volt circuits
 2. 277/480 volt circuits
 3. Emergency
 - a. Life safety branch
 - b. Critical branch
 - c. Equipment branch
 4. Voice/Data
 5. Sound reinforcement
 6. Theatrical and Architectural Dimming Controls
 7. MATV/CATV
 8. Security CCTV
 9. Security System
 10. Communications / PA Systems / Sound System Line Input and Speakers
 11. Fire Alarm
 12. Lighting and Building Management Control Systems
- F. Unless shown otherwise, do not install conduit in or below concrete building slabs.
- G. Unless shown otherwise, do not install conduit horizontally in concrete slabs.
- H. Roof penetrations shall be made in adequate time to allow the roofing installer to make proper flashing. Conduit for equipment mounted on roof curbs shall be routed through the roof curb. Conduit, gutters, pull boxes, junction boxes, etc. shall not be routed on roof unless specified otherwise. Where specifically indicated to be routed or mounted on the roof, supports shall be as specified, as recommended by roofing manufacturer and roof support manufacturer and as required by NEC. Place supports every five feet along conduit run and within 3 feet of all bends, condulets, and junction boxes. Provide roofing pad under stands as directed by Architect and as recommended by roofing manufacturer and roof support manufacturer. Provide additional unistrut supports and accessories as required.
- I. PVC coated conduit shall have all nicks and cuts to the protective coating repaired using manufacturer's approved touch-up material as recommended by manufacturer. Provide a minimum of two-wraps of 3M-50 type tape over touch-up.
- J. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer's Installation Manual. To assure correct installation, the installer shall be certified by Manufacturer to install coated conduit. Submit copies of training certification with submittal. Contractor shall coordinate installation with manufacturer's representative for field training and observation of installed PVC coated rigid galvanized conduit and fittings. Manufacturer's representative shall certify the installation is in accordance with manufacturer's installation instructions. Submit copies of installation certification prior to cover-up of underground installation.
- K. All conduit terminations at locations including but not limited to, switchgear, pull boxes, outlet boxes, stub-up, and stub-outs:
1. Provide insulated throat connectors for EMT conduits.
 2. Provide insulated bushing on all rigid conduit terminations.
 3. Provide locknuts inside and outside of all boxes and enclosures.
 4. Provide threaded type plastic bushing at all boxes and enclosures

- L. In suspended ceilings, support conduit runs from the structure, not the ceiling system construction.
 - 1. Do not support from structural bridging.
 - 2. Do not support from metal roof deck.
- M. Completely install each conduit run prior to pulling conductors. All boxes are to be accessible after completion of construction.
- N. All conduits must be kept dry and free of water or debris with approved pipe plugs or caps. Cap or plug conduit ends prior to concrete pours.
- O. Ream ends of conduits after cutting and application of cutting die to remove rough edges.
- P. Install all above concrete slab conduits perpendicular or parallel to building lines in the most direct, neat and workmanlike manner.
 - 1. Cable Tension:
 - a. 0.008 lb./cmil for up to 3 conductors, not to exceed 10,000 pounds.
 - b. 0.0064 lb./cmil for more than 3 conductors, not to exceed 10,000 pounds
 - c. 1000 lbs. per basket grip.
 - 2. Sidewall pressure: 500 lbs./ft.
 - 3. Conduit runs within the following limits of bends and conduit length between pull points shall not exceed the above installation pulling tension and sidewall pressure limits.
 - a. Three (3) equivalent 90-degree bends: not more than fifty feet (50') between pull points.
 - b. Two (2) equivalent 90-degree bends: not more than one hundred feet (100') between pull points.
 - c. One (1) equivalent 90-degree bend: not more than one hundred fifty feet (150') between pull points.
 - d. Straight pull: not more than two hundred feet (200') between pull points.
 - 4. Indicate sizes of conduits, wireway sections, and cable tray sections on the as-built drawings.
 - 5. Hold horizontal and vertical conduits as close as possible to walls, ceilings and other elements of the building construction. Conduits shall be kept a minimum of 6 inches clear of roof deck / insulation, and 2 inches clear of above floor deck / insulation.
 - 6. Install conduits to conserve building space and not obstruct equipment service space or interfere with use of space. Conduit shall not be routed on floors, paved areas or grade.
 - 7. Where a piece of equipment is wired from a switch or box on adjacent wall, the wiring shall go up the wall from the box, across at or near the ceiling, and back down to the equipment. Wiring shall not block the walkway between wall and equipment.
 - 8. Horizontal runs of conduit on exposed walls shall be kept to a minimum.
 - 9. Conduit for mechanical / plumbing equipment installed outdoors shall be routed with the associated mechanical / plumbing pipe support rack system where practical, coordinate with Divisions 22 and 23.
 - 10. Conduits installed in public areas, not concealed by architectural ceilings, shall be supported by galvanized steel channel racks to bottom of roof deck or floor deck. Conduits shall be grouped for neat workman-like appearance.
- Q. Install expansion and deflection fittings and bonding jumpers on straight runs which exceed 200-feet, on center, and at 200-feet maximum, on center, on straight runs which exceed 400-feet, and where conduits cross building expansion joints.

- R. Provide grounding bushings at concentric/eccentric knockouts or where reducing washers are used.
- S. Run conduit to avoid proximity to heat producing equipment, piping surfaces with temperatures exceeding 104 degrees F., and flues, keeping a minimum of 13-inches clear.
- T. Install conduit as a complete system, without conductors, continuous from outlet to outlet and from fitting to fitting. Make up threaded joints of conduit carefully in a manner to ensure a tight joint. Fasten the entire conduit system into position. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of four quarter bends, including those bends located immediately at the outlet or fitting.
- U. Conceal conduit systems in finished areas. Conduit may be exposed in mechanical and electrical rooms, and where otherwise shown or indicated only. Run the conduit parallel and perpendicular to the structural features of the building and support with malleable iron conduit clamps at intervals as required by NEC or on conduit racks, neatly racked and bent in a smooth radius at corners.
- V. Conduit bends shall be factory elbows or shall be bent using equipment specifically designed to bend conduit of the type used to maintain the conduit's UL listing. Conduit hanger spacing shall be 10 feet or less and as required by the NEC for all conduit. Beam clamp attachments to steel joist chords is prohibited. Beam clamps may only be used at beams, no exceptions. Connections to joists shall be made with galvanized channel extended between joist chords or with galvanized channel bearing on the vertical legs of joist chord angles.
- W. Support conduit on galvanized channel, using compatible galvanized fittings (bolts, beam clamps, and similar items), and galvanized threaded rod pendants at each end of channel and secure raceway to channel and channel to structure. Where rod pendants are not used, channel supports are to be secured to structure at each end. Conduit supports are to be secured to structure using washers, lock washers, nuts and bolts or rod pendants; use of toggle bolt "wings" are not acceptable. Support single conduit runs using a properly sized galvanized conduit hanger with galvanized closure bolt and nut and threaded rod. Raceway support system materials shall be galvanized and manufactured by Kindorf, Unistrut, Superstrut, Caddy, or Spring Steel Fasteners, Inc. Provide chrome or nickel-plated escutcheon plates on conduit passing through walls and ceilings in finished areas. Do not support conduit from other conduit, structural bridging or fire rated ceiling system. Do not support more than one conduit from a single all-thread rod support. Provide electrical insulating sleeve or wrapping for aluminum conduit supported by zinc coated supports or fasteners. Channel supports shall have cut ends filed smooth. When installed outside of the building, or in areas subject to moisture, the cut ends shall be painted with ZRC galvanized paint or equivalent.
- X. Terminate all motor connection conduits in mechanical room spaces with a floor pedestal and with "Tee" conduit at motor outlet height for flexible conduit.
- Y. Where conduit is not embedded in concrete or masonry, conduit shall be firmly secured by approved clamps, half-straps or hangers. Tie wire and short pieces of conduit used as supports and or hangers are not approved.
- Z. Where "LB" condulets are used, 2-inches and larger shall be type "LBD".

- AA. No more than 12 conduits containing branch circuits may be installed in junction boxes, pull boxes or gutters.
- BB. Flexible metal conduit and liquid tight flexible metal conduit shall only be used for final connections from junction box to equipment, light fixtures, power poles, etc. They are not to be used in lieu of conduit runs. They shall not be used for wall or roof penetrations unless they are installed in a PVC coated RGC conduit sleeve at least one size larger than the OD of the flexible conduit.
- CC. Where 3-1/2-inch conduit is specified and the required or specified material is Schedule 80 PVC, provide 4-inch conduit.
- DD. "Daisy Chaining" light fixtures installed for lay-in ceiling areas is not allowed. Each light fixture shall have its own fixture whip from junction box. The only exception being light fixtures installed end to end using chase nipples between them, or light fixtures recessed in non-accessible ceilings.
- EE. In above ceiling applications, do not install raceways, junction boxes, gutters, disconnects, etc. within 36 inches directly in front of HVAC control boxes or other equipment requiring access from a point starting from the top of control box / equipment down to ceiling.
- FF. Do not install conduit, junction boxes, etc. within 18 inches of outside edges of roof access openings.
- GG. Install minimum size 2-inch nipple, at least one, between multi-sectional panels for branch circuit independent of feeder conductors.

3.2 CONDUITS

- A. Conduit above grade indoors:
 - 1. Concealed Conduits: EMT with set screw fittings
 - 2. Exposed conduits:
 - a. Below nine feet AFF where not directly attached and against building walls, ceiling, or structure: Rigid metal conduit or x-wall RTRC.
 - b. Where subject to physical damage: Rigid metal conduit or x-wall RTRC.
 - c. Wet locations: PVC coated galvanized rigid steel or aluminum conduit
 - d. Damp Locations: Aluminum rigid conduit or x-wall RTRC.
 - e. Exposed conduits in mechanical rooms or electrical rooms shall be rigid galvanized steel or x-wall RTRC when installed below 18-inches above finished floor.
- B. Conduit installed above grade outdoors:
 - 1. Galvanized rigid steel or x-wall RTRC for conduits up utility poles and where subject to physical damage or where located less than four feet above finished floor.
 - 2. Aluminum or x-wall RTRC where not subject to physical damage and where located four feet above finished floor.
- C. Conduit where indicated underground:
 - 1. PVC Coated Galvanized rigid steel or RTRC conduit elbows and Schedule 80 PVC, RTRC, or PVC coated galvanized steel straight run conduits. PVC conduits for underground branch circuits shall be Schedule 80 or Schedule 40 PVC.
 - a. PVC conduit and fittings shall be used only for straight horizontal runs and for vertical risers at site lighting pole bases. Bending straight

- sections of PVC conduit to less than 25-foot radius or the use of PVC factory bends is not allowed.
- b. Change in direction of conduit runs, either vertical or horizontal, shall be with RTRC or PVC coated galvanized steel elbows or long sweep bends of straight PVC conduit sections. Long sweep bends of straight PVC 20-foot sections shall have a minimum radius of curvature of 25 feet and a maximum arc of 22.5degrees. Multiple long sweep bends of straight PVC sections shall be separated by a minimum of 20-feet of straight, linear, PVC sections.
 - c. Provide RTRC or PVC coated rigid galvanized steel conduit elbows and fittings with urethane interior coating at all changes in direction with radius of less than 25-feet and at all vertical runs to 18 inches above finished floor elevation. For interior slab penetrations, provide continuous RTRC or PVC coated rigid galvanized steel conduit and fittings with urethane interior coating from change in direction to 18 inches above finished floor elevation, except where stubbed-up under and inside equipment or switchgear where conduit shall be terminated at minimum two inches above concrete housekeeping pad.
 - d. Elbows for underground electrical service entrance, feeders, transformer primary / secondary, telecommunication, and low voltage conduits shall be RTRC or PVC coated rigid galvanized steel with long radius as follows:
 - 1) Up to 1-inch conduit, minimum 12-inch radius.
 - 2) 1.5-inch conduit, minimum 18-inch radius.
 - 3) 2-inch conduit, minimum 24-inch radius.
 - 4) 2.5-inch conduit, minimum 30-inch radius.
 - 5) 3-inch conduit, minimum 36-inch radius.
 - 6) 3.5 to 6-inch conduit, minimum 48-inch radius.
 - e. Conduit for all floor boxes shall be routed below building slab from floor box to nearest column, wall, or as indicated.
 - f. Conduits shall not be routed horizontally in building slab, grade beams or pavement.
2. Encase all underground conduits in concrete.
- a. Concrete shall be tinted red throughout with a ratio of 10 pounds of dye per yard of concrete unless prohibited by utility for utility conduits. Concrete encasement for utility installed conductors shall be as specified by the utility and comply with their standards and specifications. Where utility does not require but allows concrete encasement of conduits, provide concrete encasement as specified herein.
 - b. Provide minimum 3-inch concrete encasement around conduits.
 - c. Provide conduit spacers for parallel branch/feeder conduits.
 - d. When prior written approval from Owner and Architect to omit concrete encasement of conduits below building slab is given, conduits either specified or approved in writing to be routed under building slab without concrete encasement for electrical branch circuits or voice / data / video / communications horizontal drops or outlets shall be installed 18 inches below finished floor and on select fill. All other conduits, including but not limited to electrical feeders, voice / data / video / communications vertical, riser, tie, trunk, or service cable conduits shall be installed 48-inches below finished floor and on select fill.
 - e. Use suitable manufactured separators and chairs installed 4 feet on centers. Securely anchor conduit at each chair to prevent movement during backfill placement.
3. Install building voice / data / video / communications main service conduits and electrical service transformer primary and secondary conduits with top of

concrete encasement minimum 48-inches below finished grade or pavement. Voice / data / video / communications conduits and electrical service primary conduits for utility owned electrical service transformers shall also comply with the respective utility company requirements and standards. All other underground conduits outside of building other than voice / data / video / communications main service conduits and electrical service transformer primary and secondary conduits shall have top of concrete encasement at 36 inches minimum below finished grade or pavement.

4. Provide two "caution" plastic tapes at 6-inches and 18-inches below finished slab, grade, or pavement; identify as specified in Section 26 05 00.
 5. Conduits located outside building, provide magnetic locator tape at top of first compacted layer of backfill or concrete.
 6. During construction, partially completed underground conduits shall be protected from the entrance of debris such as mud, sand, and dirt by means of conduit plugs. As each section of the underground conduit is completed, a testing mandrel with diameter ¼-inch smaller than the conduit, shall be drawn through each conduit. A brush with stiff bristles shall be drawn through until conduit is clear of particles of earth, sand, or gravel. Conduit plugs shall then be installed.
 7. Utility underground conduit for Utility Company cable shall be installed per Utility Company standards, and their specifications for this project.
 8. Concrete shall be Portland Cement conforming to ASTM-C-150, Type 1, Type III or Type V if specified. Cement content shall be sufficient to product minimum strength of 2,500 PSI.
 9. Contractor shall stake out routing and location of underground conduits using actual field measurements. He shall obtain approval of the Owner and Architect before beginning trenching, horizontal drilling, and excavation.
 10. Verify location and routing of all new and existing underground utilities with the Owner and Architect on the job site. Stake out these existing utilities so that they will not be damaged. Stake out new utilities to provide coordination with other trades and with new and existing utilities, easements, property lines, restricted land use areas, and right-of-ways. Verify existing public utilities with Call811.
- D. Conduit shown in concrete walls, floor or roof slab:
1. PVC Coated Galvanized Rigid steel.
- E. Conduits that penetrate concrete slab, or within 100 feet of cooling towers, or at designated corrosive locations.
1. RTRC
 2. PVC coated galvanized rigid steel
- F. Connections to equipment mounted on roof, rotating equipment, transformers, and kitchen or food processing equipment, or where flexible conduit is required outdoors.
1. Liquid tight flexible metal conduit (1/2 inch may be used for roof top supply / exhaust fans only)
 2. Liquid tight flexible metal conduit for 24-inch maximum length
 3. Conduit for roof-mounted equipment shall be routed inside the roof curb assembly roof opening. Provide permanent lock-off device at panelboard circuit breakers serving roof equipment and accessories to enable tag-out procedures for all power routed through roof curb and to the roof mounted equipment and accessories.
- G. Light fixture whips:
1. Accessible ceilings and open structure: ½-inch flexible steel conduit or steel MC cable, length not to exceed 6-feet.
 2. Non-accessible ceilings: ½-inch flexible steel conduit. Length as required to

make a tap at an accessible j-box. Recessed light fixtures in non-accessible ceilings may be daisy chained using the light fixture's integral, UL listed j-box or internal wire way that is accessible through fixture from below the ceiling.

3. Dedicated insulated ground wire.
4. Light fixture whips shall not rest on ceiling grid or tile.
5. Light fixture whips shall not be supported from the ceiling suspension system. Support from the structure with #13 AWG galvanized iron wire pendants and Caddy clips. Do not support conduit from structural bridging. Flexible conduit and steel MC cable shall be kept a minimum of 2 inches clear of roof deck..

3.3 CONDUIT PENETRATIONS, SLEEVES AND ESCUTCHEONS

- A. Furnish sleeves for placing in construction for all conduit passing through concrete or masonry walls, partitions, beams, all floors other than grade level, and roofs. A conduit sleeve shall be one size larger than the size of conduit, which it serves except where larger sizes are required for manufactured water, fire, or smoke stop fittings.
 1. Sleeves set in concrete floor construction shall be minimum Schedule 40 galvanized steel.
 2. Sleeves shall extend 3-inches above the finished floor.
- B. Sleeves in concrete or masonry walls shall be RTRC or Schedule 40 galvanized steel. Sleeves shall be set flush with finished wall.
- C. Install manufactured UL listed water, fire, and smoke stop fittings, or caulk around conduit or cables in sleeves with sufficient UL listed fire safe insulation or foam to maintain wall or floor slab fire or smoke rating. Refer to Architecture drawings for locations of rated walls.
- D. Provide Linkseal Mechanical Seals around conduit penetrations through walls below grade. Provide a pull box to install a water stop inside wall penetration. Internally seal low voltage cabling conduit penetrations with waterproof caulking.
- E. Sleeves penetrating walls below grade shall be Schedule 40 black steel pipe with ¼-inch thick steel plate secured to the pipe with continuous fillet weld. The plate shall be located in the middle of the wall and shall be 2-inches wider all around than the sleeve that it encircles. The sleeve should extend a minimum of 24-inches on either side of the penetration. The entire assembly shall be hot-dipped galvanized after fabrication. Do not sleeve or penetrate grade beams.
- F. Conduit passing through the housing on connected equipment shall pass through a cleanly cut hole protected with a threaded steel bushing. Route conduit through roof openings, for piping and ductwork or through suitable roof jack, with pitch pocket. Coordinate location with roofing installation as required.
- G. Conduit passing through fire rated wall shall be sealed with Fire Stop. Route conduit to preserve fire resistance rating of partitions and other elements, using materials and methods under the provisions of Division 7.

3.4 POWER DISTRIBUTION UNDERGROUND FEEDER CONDUIT AND UNDERGROUND SERVICE ENTRANCE CONDUIT

- A. Power underground feeder and service entrance shall be of individual conduit encased in concrete. Unless shown otherwise, the type of conduit used shall not be mixed in any one underground conduit and shall be the size indicated on the drawings. The concrete encasement surrounding the underground conduit shall be rectangular in cross-section, having a minimum concrete thickness of 3-inches, except that conduit for 120V and

above shall be separated from control and signal conduits by a minimum concrete thickness of 3-inches. Encasement concrete shall be tinted in red.

- B. During construction, partially completed underground conduits shall be protected from the entrance of debris such as mud, sand, and dirt by means of conduit plugs. As each section of the underground conduit is completed, a testing mandrel shall be drawn through until each conduit is clear of particles of earth, sand, or gravel. Conduit plugs shall then be installed.
- C. Furnish the exact dimensions and location of power underground conduit to be encased in time to prevent delay in the concrete work.
- D. Conduit for service entrance underground conduits shall be as indicated on the drawings.
- E. Primary power underground conduit shall be installed in accordance with utility company standards and the utility company specifications for this project.

3.5 TELECOMMUNICATIONS, LOW VOLTAGE AND EMPTY CONDUIT SYSTEM RACEWAYS

- A. Conduit shall be installed in accordance with the specified requirements for conduit and with the additional requirements that no length of run shall exceed 100-feet for 1 inch or smaller trade sizes and shall not contain more than two 90-degree bends or the equivalent. Pull or junction boxes shall be installed to comply with these requirements. Provide plastic bushings at all conduit terminations. Provide a grounding bushing on each data and voice conduit.
- B. Conduits shall be installed from outlet box to above an accessible ceiling. All cables routed through open spaces (no-ceiling below roof deck or above floor deck) shall be routed in conduit. Telecommunications systems, CATV, CCTV, fire alarm and BMCS cables can be installed above accessible ceilings without conduit. Cables installed above accessible ceiling shall be plenum rated. Conduit rough in of these cables shall include a 90-degree turn-out to an accessible location with insulated bushings on the end of the conduit.
 - 1. Provide conduit from each telecommunications outlet box to accessible ceiling plenum.
 - 2. Provide conduit from each security / surveillance device outlet box to accessible ceiling plenum.
 - 3. Provide two conduits for each multi-media outlet box and each outlet box indicated to contain more than four data, audio, or video drops to accessible ceiling plenum.
 - 4. Provide the following minimum conduits for telecommunications and multi-media wall, floor, and ceiling mounted outlet boxes. Use the largest diameter conduit indicated below unless instructed otherwise in writing from the Architect:
 - a. Non-masonry outlet box: Two 1-inch conduits.
 - b. Masonry outlet box: Two 1-inch conduits, or three 3/4-inch conduits.
 - c. Where indicated differently on plans or where conflicts arise, notify the Architect / Engineer prior to installation.
- C. All conduit in which cable is to be installed by others shall have pull string installed. The nylon pull string shall have not less than 200 lb. tensile strength. Not less than 12-inches of slack shall be left at each end. Provide blank cover plate before substantial completion if box is for a future installation after substantial completion of the project. Conduit shall extend to a minimum six inches above nearest accessible ceiling and be turned horizontally with plastic bushing at terminations.

- D. Conduits for Building Entrance Facilities:
1. Underground Outside Plant: Install a pull box every 300-feet or after 180 degree turns.
 2. Inside Plant: Install a pull box every 150-feet or after 180 degree turns. All turns shall be large sweeps, not sharp 90s, with the radius of the sweep at least 10X the diameter of the conduit. Hence, a 4-inch conduit requires a 40-inch minimum radial sweep. If field conditions absolutely mandate a sharp 90-degree bend to be installed, then a pull box shall be installed at that location regardless of distance.
 3. Building entrance facilities shall not terminate in an IDF or any other space except the MDF.
 4. Coordinate the termination location of the building entrance facilities in the MDF with the room layout and equipment configuration.
 5. Provide 4-inch conduit unless indicated otherwise. Provide (3) fabric innerducts in each 4-inch conduit.

3.6 EXTERIOR IN-GRADE PULL BOXES

- A. Provide pull boxes where specified and as required.
- B. Pull boxes located in pavement shall be set with proper extensions so that top of cover is flush with pavement.
- C. Pull boxes located in non-paved areas shall be set two-inches above surrounding finished grade. Provide 12-inch wide by 8-inch deep reinforced concrete crown around neck or opening and sloped down away from pull box opening.

3.7 IDENTIFICATION

- A. Conduit Systems: Provide adequate marking of conduit larger than one inch exposed or concealed in interior accessible spaces to distinguish each run as either a power (120/208V or 277/480V) or signal / telecommunication conduit (Fire Alarm, BAS, BMCS, Security, CCTV, Access Control, Intrusion Detection, Telecom, etc.). Except as otherwise indicated, use orange banding with black lettering. Provide self-adhesive or snap-on type plastic markers. Locate markers at ends of conduit runs, near switches and other control devices, near items of equipment served by the conductors, at points where conduit passes through walls or floors or enters non-accessible construction, and at spacing of not more than 50-feet along each run of exposed conduit. Switch-leg conduit and short branches for power connections need not be marked, except where conduit is larger than 1-inch.

END OF SECTION 26 0533

SECTION 26 0535 - ELECTRICAL CONNECTIONS FOR EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Electrical connections as required and scheduled, and as specified.

1.2 RELATED WORK

- A. Refer to other Divisions for specific individual equipment electrical requirements.

1.3 QUALITY ASSURANCE

- A. UL Label: Products shall be UL listed to the extent possible.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

- A. General: For each electrical connection indicated, provide a complete assembly including, but not limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire nuts, and other items and accessories needed to complete splices and terminations.
- B. Raceways: Refer to related sections.
- C. Conductors and Connectors: Refer to related section. Conductors at equipment terminations shall be copper.
- D. Terminals: Provide electrical terminals as indicated by the terminal manufacturer for the application.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. General: Install electrical connections as shown, in accordance with applicable portions of the NECA Standard of Installation, and industry practices.
- B. Conductors: Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Where possible, match conductors of the electrical connection for interface between the electrical supply and the installed equipment.
- C. Splice Insulation: Cover splices with electrical insulation equivalent to, or of a higher rating than, insulation on the conductors being spliced.
- D. Appearance: Prepare conductors by cutting and stripping covering, jacket, and insulation to ensure a uniform and neat appearance where cables and wires are terminated.
- E. Routing: Trim cables and wires to be as short as practical. Arrange routing to facilitate inspection, testing, and maintenance.

- F. Motor Connections: Where possible, terminate conduit in conduit boxes at motors. Where motors are not provided with conduit boxes, terminate the conduit in a suitable conduit, and make motor connections. Conduit passing through the housing on connected equipment shall pass through a cleanly cut hole protected with an approved grommet. For all AHU or fan motors and all other motors 10 HP and larger, at the motor connection do not use wire nuts. Provide copper alloy split bolt connectors or compression lugs and bolts. Insulate connection with Scotch Super 88 vinyl electrical tape over rubber tape, or Tyco Gelcap Motor Connection Kit.
- G. Conduit connections to equipment including, but not limited to, Variable Frequency Drives, Manual and Automatic Transfer Switches, Surge Suppression Devices, motor controllers, electrical disconnects, food service / processing equipment, electronics, control panels and Owner furnished equipment:
 - 1. Make conduit penetrations only at the bottom flat surface of the equipment and only where permitted by the equipment manufacturer to avoid un-intentional water entry. Coordinate installation of electrical connections for equipment with equipment installation work. Where equipment manufacture does not permit a bottom conduit entry, verify with Owner/Engineer and locate the conduit entry at the side surface as close as possible to the bottom of the enclosure.
 - 2. Where conduit originates from an elevation above the conduit entry, provide a "T" conduit below the enclosure's bottom elevation. Provide conduit from the conduit up to the enclosure bottom horizontal surface for electrical connection.
- H. Identification: Refer to Electrical General Provisions for identification of electrical power supply conductor terminations with markers approved as to type, color, letter and marker size by the Architect. Fasten markers at each termination point, as close as possible to each connecting point.
- I. Equipment and Furnishings: Refer to other Divisions. Coordinate power and control provisions shown for equipment and furnishings with the provisions required for the furnished equipment and furnishings. Where the power and control requirements are less than or equal to those specified, modifications to power and control provisions shall be made at no cost as a part of coordination. Where power and control requirements are in excess of those shown, notify the Architect in writing of the requirements.

END OF SECTION 26 0535

SECTION 26 0537 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide electrical box and fitting work as required, scheduled, indicated, and specified.

1.2 QUALITY ASSURANCE

- A. UL Label: Electrical boxes and fittings shall be UL listed.

PART 2 - PRODUCTS-- Provide products manufactured in the USA

2.1 FABRICATED MATERIALS

- A. Interior Outlet Boxes: Provide galvanized steel interior outlet wiring boxes, of the type, shape, and size, including depth of box, to suit respective locations and installation. Construct with stamped knockouts in back and sides. Provide gang boxes where devices are shown grouped. Single box design; sectional boxes are not acceptable, except for wall mounted electronic displays.
1. Type of Various Locations:
 - a. Wall mounted interactive media boards, video displays, televisions, electronic signage and similar installations; recessed wall mounted box for power and/or multi-media (low voltage) outlets: Arlington Industries #TVBS 613, 4-gang steel box with white trim plate.
 - b. Technology, data, voice, video and multi-media outlet boxes at locations other than wall mounted interactive media boards, video displays, televisions, electronic signage and similar installations: minimum 4-inch square (2-gang), 3-inch deep interior outlet boxes. Raco #260H large capacity box with 1/2 through 2-inch knockouts.
 - c. Security, access control, and video surveillance outlet boxes: single gang, 3-inch deep outlet boxes mounted long axis vertically.
 - d. All other applications: minimum 4-inch square (2-gang) 2-1/8-inch deep boxes.
 - e. Masonry Walls: Galvanized switch boxes made especially for masonry installations; depths of boxes must be coordinated for each installation.
 - f. Surface: Type FS or FD box with surface cover.
 - g. Corrosive locations or natatorium areas: 316 stainless steel construction suitable for the installation.
 - h. Hazardous (Classified) Locations: Explosion proof boxes, seals and fittings.
 - i. Special: Where above types are not suitable, boxes as required, taking into account space available, appearance, and Code requirements
 2. Interior Outlet Box Accessories: Outlet box accessories required as for installation, including covers or wall device plates, mounting brackets, wallboard hangers, extension rings, plaster rings for boxes in plaster construction, fixture studs, cable clamps and metal straps for supporting outlet boxes. Accessories shall be compatible with outlet boxes used and meet requirements of individual wiring.
- B. Damp Location Outlet and Damp or Wet Location Switch Boxes: Deep type, hot dipped galvanized cast-metal weatherproof outlet wiring boxes, of type, shape, and size required. Include depth of box, threaded conduit ends, and stainless steel cover plate

with spring-hinged waterproof caps suitable for application. Include faceplate gasket and corrosion-resistant, tamper / vandal proof fasteners.

- C. Wet Location Outlet Boxes: Hot dipped galvanized cast-iron weatherproof outlet wiring boxes, of type, shape, and size required. Include depth of box, threaded conduit ends.
- D. Junction and Pull Boxes: Galvanized sheet steel junction and pull boxes, with screw-on covers, of type, shape, and size, to suit respective location and installation.
 - 1. Type for Various Locations:
 - a. Minimum Size: 4-inch square, 2-1/8-inches deep.
 - b. 150 Cubic Inches in Volume or Larger: Code gauge steel with sides formed and welded, screw covers unless shown or required to have hinged doors. All boxes mounted above ceiling shall have screw covers. Boxes in all other areas with covers larger than 12-inches shall have hinged with screw covers. Knockouts factory stamped or formed in field with a cutting tool to provide a clean symmetrically cut hole.
 - c. Exterior or Wet Areas: 304 stainless steel NEMA 4X construction with gaskets and corrosion-resistant fasteners
- E. Conduit Bodies: Provide galvanized cast-metal conduit bodies, of type, shape, and size, to suit location and installation. Construct with threaded conduit ends, removable cover, and corrosion-resistant screws.
- F. Bushings, Knockout Closures, and Locknuts: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts, and insulated conduit bushings of type and size to suit use and installation.
- G. Outlet boxes in fire rated walls: Provide 2-hour rated gasket within box and below cover, equal to Rectorseal Metacaulk box guard and cover guard.

PART 3 - EXECUTION

3.1 INSTALLATION OF BOXES AND FITTINGS

- A. Install electrical boxes and fittings as shown and as required, in compliance with NEC requirements, in accordance with the manufacturer's written instructions, in accordance with industry practices.
- B. Provide recessed device boxes for wall mounted interactive media boards, video displays, televisions, electronic signage and similar installations.
- C. Provide minimum 4-inch square (2-gang), 3-inch deep interior outlet boxes for technology, data, voice, video, and multi-media outlet boxes at locations other than wall mounted interactive boards, video or visual displays. Provide single gang only, 3-inch deep outlet boxes mounted long axis vertically for security, access control, and video surveillance, coordinate with security equipment installation. Provide minimum 4-inch square (2-gang) 2-1/8-inch deep boxes for all other applications. Where indicated differently on plans or where conflicts arise, notify the Architect / Engineer prior to installation. Box extenders or plaster rings shall not be used to increase size. Provide increased box size as required.
- D. Junction and pull boxes, condulets, gutters, located above grid ceilings shall be mounted within 18-inches of ceiling grid. Junction and pull boxes above grid ceilings shall be mounted in the same room served. Junction boxes and pull boxes required for areas with inaccessible ceilings shall be located above the nearest accessible ceiling area. All

junction box or pull box openings shall be side or bottom accessible. Removal of light fixtures, mechanical equipment or other devices shall not be required to access boxes. Outlet boxes above ceiling for low voltage terminations shall face towards the floor.

- E. Use outlet and switch boxes for junctions on concealed conduit systems except in utility areas where exposed junction or pull boxes can be used.
- F. Determine from the drawings and by measurement the location of each outlet. Locate electrical boxes to accommodate millwork, fixtures, marker boards, and other room equipment at no additional cost to the Owner. The outlet locations shall be modified from those shown to accommodate changes in door swing or to clear interferences that arise from construction as well as modifying them to center in rooms. The modifications shall be made with no cost as part of coordination. Check the conditions throughout the job and notify the Architect of discrepancies. Verify modifications before proceeding with installation. Set wall boxes in advance of wall construction, blocked in place and secured. Set all wall boxes flush with the finish and install extension rings as required extending boxes to the finished surfaces of special furring or wall finishes. Provide wall box support legs attached to stud to prevent movement of box in wall.
- G. Unless noted or directed otherwise at installation, place outlet boxes as indicated on architectural elevations and as required by local codes.
- H. Outlets above counters, mount long axis horizontally. Refer to architectural elevations and coordinate to clear backsplash and millwork.
- I. Provide pull boxes, junction boxes, wiring troughs, and cabinets where necessary for installation of electrical systems. Surface mounted boxes below 9 feet and accessible to the public shall not have stamped knockouts.
- J. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
- K. Provide knockout closures to cap unused knockout holes in boxes.
- L. Locate boxes and conduit bodies to ensure access to electrical wiring. Provide minimum 12-inch clearance in front of box or conduit body access.
- M. Secure boxes to the substrate where they are mounted, or embed boxes in concrete or masonry.
- N. Boxes for any conduit system shall not be secured to the ceiling system, HVAC ductwork or piping system.
- O. Provide junction and pull boxes for feeders and branch circuits where shown and where required by NEC, regardless of whether or not boxes are shown.
- P. Coordinate locations of boxes in fire rated partitions and slabs to not affect the fire rating of the partition or slab. Notify the Architect in writing where modification or construction is required to maintain the partition or slab fire rating.
- Q. Exterior boxes installed within 50-feet of cooling towers or water treatment areas shall be of 304 stainless steel, weatherproof NEMA 4X construction.
- R. Box extenders or plaster rings shall not be used to increase the Code mandated cable capacity of a box. Provide proper size box.

- S. All box covers shall be labeled with Panel ID and circuit numbers of all circuits available in box using permanent black marker. Boxes containing main feeders are to list where fed from and load (example "MSB to Panel HA"). Information listed is to be legible, markovers are not acceptable. Multi-sectional panel numbers are not to be listed on covers (example "LA2" referring to Panel LA sec. 2 is to be listed as "LA"). Label covers for special applications explaining contents (example "Emerg. Gen. Annunciator controls", "IDF ground"). Do not attach box covers that have both sides painted or labeled differently. In public areas where boxes are painted same color as room per architect, label inside covers. Boxes that are not used shall be labeled as not used and include panel ID. Example "Not Used Panel LA". Unused raceways not in sight of panel shall be terminated in a box and labeled not used and include panel identification.
- T. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- U. Use flush mounting outlet box in finished areas unless specifically indicated as being used with exposed conduit.
- V. Locate flush-mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- W. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches with stud separation. Provide minimum 24 inches with separation in acoustic rated walls.
- X. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness. Provide UL listed materials to support boxes in walls to prevent movement. Ensure box cannot be pushed inside wall.
- Y. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- Z. Install flush mounting box without damaging vapor barriers, wall insulation or reducing its effectiveness.
- AA. Use adjustable steel channel fasteners for hung ceiling outlet box.
- BB. Do not fasten boxes to ceiling support wires.
- CC. Support systems are to hang vertically straight down. All-thread supports, when used, are not to be installed at an angle or bent.
- DD. Use gang box where more than one device is mounted together. Do not use sectional box.
- EE. Use gang box with plaster ring for single device outlets.
- FF. Support outlets flush with suspended ceilings to the building structure.
- GG. Mount boxes to the building structure with supporting facilities independent of the conduits or raceways.
- HH. Where multiple feeders are in one pull box, conductors shall be wrapped with 3M No. 7700 Arc and fireproof tape.

- II. Provide plaster rings of suitable depth on all outlet boxes. Face of plaster ring shall be within 1/8 inch from finished surface.
- JJ. Equip boxes supporting fixtures designed to accept fixture studs with 3/8-inch stud (galvanized malleable iron) inserted through back of box and secured by locknut. Boxes not equipped with outlets shall have level metal covers with rust-resisting screws.
- KK. Do not mount junction boxes above inaccessible ceilings or in inaccessible spaces. Do not mount junction boxes above ceilings accessible only by removing light fixture, mechanical equipment or other devices. At inaccessible spaces use junction box furnished with light fixture or light fixture wiring compartment UL listed for through wiring.
- LL. No more than 12 conduits containing branch circuits may be installed in any junction or pull box.
- MM. All junction boxes shall be protected from building finish painters' over spray and from fire proofing overspray. Remove protective coverings when painting and fire proofing are complete.
- NN. Bond equipment grounding conductor to all junction and pull boxes.
- OO. Do not mount boxes or conduit bodies on walls directly above electrical panels or switchgear located next to walls.
- PP. Do not mount boxes or conduit bodies within 18 inches of outside edges of roof access openings.

3.2 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused box openings.

END OF SECTION 26 0537

SECTION 26 0540 - ELECTRICAL GUTTERS AND WIREWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide electrical gutter work as shown, as specified and as required.
- B. Application: The types of electrical gutters required for the project include the following:
 - 1. Electrical wiring gutters
 - 2. Voice / Data / Video / Communication and signal distribution wireway

1.2 QUALITY ASSURANCE

- A. UL Label: Gutters and wireways shall be UL labeled.

PART 2 - PRODUCTS

2.1 ELECTRICAL GUTTERS AND WIREWAYS

- A. General: Provide hinged electrical gutters and wireways in the types and sizes indicated or required, minimum 16 gauge thickness, with rounded edges and smooth surfaces; constructed in compliance with applicable standards; with features required.
- B. Size: Provide size indicated. Where size is not indicated, construct in accordance with the NEC and other standards. Gutters shall be of manufacturer's standard lengths, without field cutting or field extensions.
- C. Accessories: Provide gutter and wireway accessories where indicated, constructed of same metal and finish as gutters or wireways.
- D. Supports: Provide gutter and wireway supports indicated, conforming to NEC, and as recommended by the manufacturer, and as specified in Section 26 05 33 Conduit Systems.
- E. Materials and Finishes: NEMA 1 gutters and wireways shall have gray powder coat finish over galvanized steel. Gutters and wireways installed outside shall be NEMA 3RX minimum. Gutters or wireways installed within 100-feet of cooling towers, at kitchen or food preparation areas, and natatorium, spa or therapy pool areas shall be of 304 stainless steel NEMA 4X construction.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide gutters and wireways only where specified or required. Use of gutters and wireways shall be kept to a minimum.
- B. Finishing: Remove burrs and sharp edges of gutters and wireways wherever they could be injurious to conductor insulation or jacket.
- C. Installation: Install gutters and wireways where shown or required, in accordance with the manufacturer's written instructions, NEC, NECA "Standard of Installation," and with recognized industry practices to ensure that the gutters and wireways comply with the specified requirements. Comply with requirements of NEMA and the NEC pertaining to installation of electrical gutters.

- D. Grounding: Electrically ground gutters and wireways to ensure continuous electrical conductivity. Provide equipment grounding conductor.
- E. Conductors:
 - 1. Complete gutter and wireway installation before starting the installation of conductors.
 - 2. Provide sufficient space to permit access for installing, splicing, and maintaining the conductors.
- F. A maximum of 12 conduits containing branch circuits shall be allowed to be installed in any gutter or wireway.

END OF SECTION 26 0540

SECTION 26 2416 - PANELBOARDS AND ENCLOSURES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Panelboards and enclosures, including cabinet, as shown, scheduled, indicated, and specified.

1.2 QUALITY ASSURANCE

- A. UL Standards: Panelboards and enclosures shall confirm to all applicable UL standards and shall be UL labeled.

1.3 SUBMITTALS

- A. Indicate:
 1. Detailed dimensions.
 2. Enclosure material, finish, and NEMA classification type.
 3. Location of main circuit breaker.
 4. Mounting and trim.
 5. Acceptable incoming conductors' size.
 6. Electrical characteristics including voltage, ampacity, overcurrent device frame size and trip ratings, bus material and rating, withstand ratings, lugs, and time current curves of all overcurrent devices and components.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Schneider Electric - Square D
- B. ABB-General Electric Co.
- C. Siemens
- D. Eaton

2.2 MATERIALS AND COMPONENTS

- A. General: Panelboards shall be dead-front type equipped with fusible switches or circuit breakers as shown and as required.
- B. The overcurrent protective device short circuit, coordination and arc flash studies performed by the overcurrent protective device manufacturer shall be used by the respective switchgear vendor(s) to select appropriate equipment, switchgear, and overcurrent protective device characteristics such as but not limited to: equipment bracing, AIC rating, circuit breaker frame size and trip settings, and fuse type/class. The appropriate equipment suitable and required by the studies for code compliance shall be included with the submittal data for review and provided at no additional cost to the Owner. The appropriate equipment recommended by the studies for enhanced selective coordination or enhanced arc flash energy reduction beyond code compliance shall be included with the submittal data for review and consideration purposes by the engineer.
- C. Busing Assembly: Panelboard phase, neutral, and equipment ground busing shall be

copper. Bus structure and mains shall have ratings as shown and scheduled. Furnish a bare uninsulated ground bus inside each panelboard enclosure. Two section panelboards shall be connected with copper cable, with an ampacity conforming to the upstream overcurrent device. Neutral bus termination quantity for branch circuit panelboards shall match or exceed the maximum number of single pole circuit breakers the panelboard will accept.

- D. Main circuit breakers and feeder / branch circuit breakers:
1. Less than 125 Amps: Thermal magnetic with factory fixed trip.
 2. 125-600 Amps: Thermal magnetic with adjustable instantaneous trip of 5X – 10X with short time tracking.
 3. 601 Amps and larger: Solid state true RMS sensing with adjustable: current set by rating plug or adjustable dial, I²t settings, ground fault (where required), instantaneous trip, and short time trip; 80-percent continuous current rating.
 4. Provide permanent lock-off device for all fire alarm system branch circuit breakers, for all smoke control fans and equipment, and where indicated or required for circuit breaker to be used as a remote safety disconnect switch.
 5. General requirements:
 - a. Make prepared space provisions for additional breakers or fused switches so that no additional bus or connectors will be required to add circuit breakers or fused switches in the available device mounting space.
 - b. Two and three pole breakers shall have internal common trips.
 - c. All circuit breakers used as the main or branch mounted back-fed main shall be bolt-on. All circuit breakers used in 600 Amp and smaller panelboards shall be bolt-on breakers. Circuit breakers for distribution panelboards rated 601 amps and larger shall have plug-on or bolt-on circuit breakers.
 - d. Branch circuit panelboard shall have interrupting capacity as shown or as required, but in no case less 10k AIC for 120/208/240-Volt systems, and 18k AIC for 277/480-Volt systems.
 - e. 15 and 20 Amp circuit breakers for lighting circuits shall be UL listed switch duty (SWD).
 - f. Personnel ground fault interrupter (GFI) circuit breakers, where shown, shall be maximum 5 mA ground fault trip and shall include a TEST button.
 - g. Equipment ground fault interrupter (EGFI/EGPD) circuit breakers, where shown or required shall be 30mA ground fault trip and shall include TEST button.
 - h. Circuit breakers with 1,200 Amp and larger frame shall have Energy Reducing Maintenance Switching with local status indicator (ERMS).
- E. Fusible Switches for distribution panelboards: Fusible switches shall be quick-make, quick-break type. Each switch shall be enclosed in a separate steel enclosure. The enclosure shall employ a hinged cover for access to the fuses. Interlock cover with the operating handle to prevent opening the cover when the switch is in the ON position. This interlock shall be constructed so that it can be overridden for testing fuses without interrupting service. The switches shall have padlocking provisions in the OFF position. Switches shall include positive pressure rejection type fuse clips for use with UL Class J fuses and be UL labeled for 200,000 AIC.
- F. Spaces: Where space for future breakers or switches is shown, panelboard enclosure shall include removable blank panels or knockouts to allow installation of future breakers or switches, prepared spaces, and panelboard busing shall be complete, including required connectors.

- G. Integrated Equipment Rating: Do not apply series ratings. Each panelboard, as a complete unit, shall have a short-circuit rating equal or greater than the available short circuit current. Rating shall have been established by tests on similar panelboards with the circuit breakers or fusible switches installed.
- H. Panelboard Enclosures:
1. Provide sheet steel enclosures, minimum 16-gauge nominal thickness, with multiple knockouts, unless shown otherwise. Provide all NEMA 1 panelboard fronts with spring-loaded door pulls, and flush lock and key, panelboard enclosures keyed alike to match the Owner's standard key system; coordinate with Owner.
 2. All NEMA 1 enclosure panelboards shall be hinged "door-in-door" type with interior hinged door with hand operated latch or latches, as required providing access only to circuit breaker or fusible switch operating handles, not to exposed energized parts. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips, or other fasteners, requiring a tool for entry. Hand operated latches are not acceptable. Push inner and outer doors shall open left to right. Manufacturer hardware (OEM), screws, and bolts shall be used to secure dead fronts and covers. Do not use third party hardware. Do not use power tools to secure panel hardware. Provide gray powder coat finish over a rust inhibitor.
 3. Equip with interior circuit directory frame, card, and clear plastic covering for panelboards.
 4. Panelboards located in kitchen preparation or natatorium areas shall have Type 316 stainless steel front, door, and trim with a NEMA 1 rating for the entire enclosure.
 5. Panelboards at exterior locations shall be NEMA 4X Type 316 stainless steel.
 6. Panelboards at hose down areas, cooling towers, in greenhouses, and other corrosive locations shall be NEMA 4X 316 stainless steel.
 7. Enclosure shall be for recessed or surface mounting as shown or as required.
 8. Enclosures shall be fabricated by the same manufacturer as panelboards to be enclosed. Multi-section panelboards shall have same physical dimensions.

PART 3 - EXECUTION

3.1 INSTALLATION OF PANELBOARDS AND ENCLOSURES

- A. General: Install panelboards and enclosures, as shown, including electrical connections, in accordance with the manufacturer's written instructions, the requirements of NEC, NECA Standard of Installation, and industry practices. Circuit breakers shall be factory installed except for required field modifications due to actual site conditions.
- B. Coordination: Coordinate installation of panelboards and enclosures with conductor and raceways installation work.
- C. Anchoring: Anchor enclosures to walls and structural surfaces ensuring that they are permanently and mechanically secured.
- D. Directory Card: Provide a typed circuit directory card(s) upon completion of work. Directory card shall be of super heavy-weight index card stock, 110 lb, white. Directory shall include type of load (i.e.: receptacles, lighting, exhaust fan, etc.) and location (i.e.: Room 102, Office, etc.) Room number shall be identified as the actual graphics room number assigned to the space and not the room number identified on the Plans. Circuits with shunt trip shall be identified with the control circuit operating the shunt trip (i.e.:

- Kitchen Hood No. 2). Shunt trip breakers with common trip circuit shall be grouped in the panelboard (i.e.: circuits 1, 3, 5 and 7).
- E. Fuses: Install fuses, of the ratings and class shown.
 - F. Circuit Arrangement: Branch circuits shall be arranged to provide the best possible phase balance, unless shown otherwise.
 - G. Panelboards not intended to be used as service entrance (SE) rated or for establishing a separately derived neutral system shall have the factory installed neutral to ground bonding screws and straps removed and disposed of.
 - H. Recessed or flush mounted panelboards: Terminate spare conduits in junction box 18-inches above accessible ceiling close to panelboard location. Label junction box cover as "not used" and include panel identification.
 - 1. Provide (3) 1-inch and (3) $\frac{3}{4}$ -inch spare conduits above accessible ceiling to j-box from each panelboard section.
 - 2. Where recessed panelboard is located above another building floor, also provide (3) 1-inch and (3) $\frac{3}{4}$ -inch conduits to j-box in ceiling space on floor below.
 - I. Conductors shall be bent neatly opposite the fuse switch or circuit breaker to which they are to be attached. Vertically installed conductors shall be neatly tie-wrapped. Conductors shall be connected in a neat and professional manner. Conductors brought in from the top or bottom of the cabinet shall be bent neatly opposite the fuse or circuit breaker to which they are to be attached. Each conductor shall be run along the full height of the panel and returned to the circuit breaker or fuse location to allow relocation of the conductor to any position along the bus. Panelboard shall be cleaned of all construction debris prior to substantial completion review. Neutral and grounding conductors shall be installed similar to the phase conductors.
 - J. Circuit breakers and conductors installed for SPD devices shall be located on the same side as the SPD to allow the shortest and straightest run of conductors in respect to the location of the SPD device. Route all conductors to the SPD device with straight as possible run, using longest sweep bends and the shortest conductor length possible. Twist all SPD conductors and secure with tie straps wherever possible.
 - K. Install copper ground bus for copper ground conductors. Ground conductors size #1 and larger are to be landed to panelboard enclosure with mechanical lugs and not to ground bus.
 - L. Install panels so that breaker number 1 is the top left breaker.
 - M. In panels that contain multi-layered neutral bus, install neutrals beginning with the back neutral bus row and work forward. Do not make up neutrals on front neutral bus row unless all other rows are full.
 - N. Label breaker mounting space with stick-on number labels.
 - O. Mount the fully aligned panelboard such that the maximum height of the top circuit breaker above the finished floor shall not exceed 78-inches. Mount panelboards as high as practical and such that the bottom of the cabinets will not be less than 6 inches above the finished floor.

3.2 TESTING

- A. Before energizing, energization, check for continuity of circuits and short circuits.
- B. Provide thermal infrared scan of panelboards under full load as directed and witnessed by Owner. Correct any deficiencies causing abnormal heating and repeat the scan. Provide digital video documentation with deficiencies corrected for comparison to future test. Make corrections as needed as soon as possible as directed by the Owner. Repeat the scan at the 11-month prior to closeout, and make corrections prior to close-out.

END OF SECTION 26 2416

SECTION 26 2425 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Safety and disconnect switch work where required, scheduled, indicated, specified, and required. For switches indicated or rated above 1,200 Amps, provide switchboard construction as specified for switchboards.
- B. UL Approved: Safety and disconnect switches shall have UL approval and the UL label.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Schneider Electric - Square D
- B. ABB-General Electric Co.
- C. Siemens
- D. Eaton

2.2 ENCLOSED SWITCHES

- A. General: Provide heavy duty type, dead-front, sheet steel enclosed, surface-mounted safety switches of the type and size indicated. Safety switches shall be rated for the voltage of the circuit where they are installed. Safety switches used as motor disconnects shall be rated for the motor horse power served.
- B. The overcurrent protective device short circuit, coordination and arch flash studies performed by the overcurrent protective device manufacturer shall be used by the respective switchgear vendor(s) to select appropriate equipment, switchgear, and overcurrent protective device characteristics such as but not limited to: equipment bracing, AIC rating, circuit breaker frame size and trip settings, and fuse type/class. The appropriate equipment suitable and required by the studies for code compliance shall be included with the submittal data for review and provided at no additional cost to the Owner. The appropriate equipment recommended by the studies for enhanced selective coordination or enhanced arc flash energy reduction beyond code compliance shall be included with the submittal data for review and consideration purposes by the engineer.
- C. Switch Mechanism:
 - 1. Safety switches shall be quick-make, quick-break type with permanently attached arc suppressor. Constructed so that switch blades are visible in the OFF position with the door open. The operating handle shall be an integral part of the box, not the cover. Switch shall have provision to padlock in the OFF position. Safety switches shall have a cover interlock to prevent unauthorized opening of the switch door when the switch mechanism is in the ON position, or closing of the switch mechanism when the switch door is open.
 - 2. Cover interlock shall have an override mechanism to permit switch inspection by authorized personnel. Current-carrying parts shall be constructed of high conductivity copper with silver-plated switch contacts. Lugs shall be suitable for copper conductors and front removable.

- D. Neutral: Provide safety switches with number of switched poles indicated. Where a neutral is present in the circuit, provide a solid neutral with the safety switch. Where a ground conductor is present in the circuit, provide a separate solid ground with the safety switch.
- E. Auxiliary Contacts: Disconnect switches related to all smoke control fans shall have auxiliary contacts for fire alarm system monitoring of the position of the disconnect switch.

2.3 ENCLOSED SWITCHES WITH OVERCURRENT AND/OR GROUND FAULT PROTECTION

- A. Overcurrent protective devices 1,200 Amps and below:
 - 1. Where switch is intended as a building service disconnect provide solid neutral and ground bus and service entrance SE rating.
 - 2. Molded case circuit breakers:
 - a. Greater than 800 Amp: Solid state true RMS sensing with adjustable: current, I²t settings, ground fault (where required), instantaneous trip, and short time trip; 80-percent continuous current rating.
 - b. 800 Amp and smaller: Solid state true RMS sensing with fixed current setting by rating plug or dial. Breaker shall have adjustable instantaneous trip function with short time tracking.
 - c. 1,200 Amp and larger frame circuit breakers regardless of trip shall have Energy Reducing Maintenance System switch with local status indicator (ERMS).
 - 3. Fusible switches:
 - a. Quick-make, quick-break units utilizing the double-break principle of circuit interrupting to minimize arcing and pitting and shall conform to the ratings shown.
 - b. Individual door over the front, equipped with a voidable interlock that prevents the door from being opened when the switch is in the ON position unless the interlock is purposely defeated by activation of the voiding mechanism. All switches shall have externally operated handles.
 - c. 600 Amps and below equipped for Class J fuses.
 - d. 601 Amps and above shall be equipped for Class R or L fuses.
 - e. When required by the latest edition of the NEC or the AHJ, 1,200 Amp fused switches regardless of fuse size installed shall have Energy Reducing Maintenance System switch with local status indicator (ERMS).
- B. Ground Fault Interrupter (GFI) protection: Where shown or required, ground fault protection shall be achieved with adjustable pickup for ground fault currents, field-adjustable from 200 amperes and instantaneous to 60 cycle time delay. The ground fault protection system shall include necessary current sensors, internal wiring, and relays to coordinate opening the monitored faulted circuits.
 - 1. Ground fault protection shall be set at minimum setting for both current and time during construction. The manufacturer shall include in the submittal data the minimum setting of the device and the recommended setting for normal building operation.
 - 2. The ground fault system shall be factory-tested before shipment as specified:
 - a. The manufacturer shall provide a factory ground fault protection system test for circuit testing and verification of tripping characteristics. The manufacturer shall pass predetermined values of current through the sensors and measure the tripping time for each phase and neutral. The measured time-current relationships shall be compared to the trip-characteristic curves. If the ground fault device trips outside the range of

values indicated on the curve, the ground fault device shall be replaced or recalibrated.

- b. Relays, electrically operated switches, shunt-trip switches, circuit breakers, and similar items shall have proper voltages applied to their circuits and satisfactory operation demonstrated.
- c. Upon completion of the factory ground fault protection system test, the current and time on each ground fault device shall be set to minimum values.

2.4 ENCLOSURES

- A. Enclosures in indoor locations shall be NEMA 1 unless shown otherwise.
- B. Enclosures in exterior locations shall be NEMA 4X stainless steel.
- C. Enclosures at kitchen and food preparation locations, exterior kitchen supply and exhaust fans, hose down areas, cooling towers, in greenhouses, and in other corrosive areas shall be NEMA 4X, stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install safety and disconnect switches where required or indicated, in accordance with the manufacturer's written instructions, requirements of the NEC, NECA Standard of Installation, and industry practices. Provide fuse identification label when fused switches are required showing type and size inside door of each switch. Include devices in coordination study to indicate overcurrent devices will selectively coordinate.
- B. Location: Provide safety switches within 50' and in sight of motor served. There shall be minimum code required clearance in front of safety switch and a clear path in which to access the switch. (i.e.: not having to walk and/or stand on obstacles such as drain pans on floor to service).
- C. Supports: Provide all safety and disconnect switches with galvanized angle or other supports where mounting on wall or other rigid surface is impractical. Switches shall not be supported by conduit alone. Where safety and disconnect switches are mounted on equipment served, the switch shall not inhibit removal of service panels or interfere with access areas, not void the warranty of the equipment served. Provide mounting hardware that will allow removal of safety and disconnect switches with common work tools. Do not utilize drive pin anchors through enclosure.
- D. Ground Fault Interrupter (GFI) test and settings: Where adjustable ground fault interrupter settings are provided or required, after completion of construction and before final acceptance testing, the ground fault protection system shall be field-tested and reset to the manufacturer's settings for both current and time by a representative of the manufacturer's engineering service department. After the test, set ground fault to 50-percent of the overcurrent device rating.
- E. Safety and Disconnect Switches: Install disconnect switches for motor-driven equipment, appliances, motors, and motor controllers within sight of the controller position unless indicated otherwise.
- F. Variable Frequency Drive (VFD) Warning Plaque: Provide VFD warning plaque at safety disconnect switches which are located down-stream of VFDs. Secure plaque to

disconnect switch or immediately adjacent to disconnect switch with fasteners. Plaque shall be Yellow-White-Yellow 3-layer plastic laminated engraved with: "WARNING" (1/2 Inch Letters). "TURN OFF VFD BEFORE OPENING THIS SWITCH FOR MAINTENANCE." (1/4 inch letters).

- G. Provide disconnect switch for electric duct heaters.
- H. Where disconnect switch is used or indicated as the utility service building disconnect, provide main bonding jumper and neutral to ground bond connected to the building's grounding system. Do not bond neutral to ground when there is a neutral to ground bond upstream from the same derived neutral system serving the disconnect switch.
- I. Disconnect switches related to all smoke control fans shall have auxiliary contacts for fire alarm system monitoring of the position of the disconnect switch, coordinate with Division 28. Coordinate with fire detection and alarm contractor for the fire alarm and detection system to monitor all disconnect switches open/closed position that serve the smoke control system. All fire alarm and control wiring directly related to the monitoring of the supply power disconnect switches and control of the smoke control fans shall be installed in conduit.

3.2 TESTING

- A. General: Before energizing, check for continuity of circuits and short circuits.
- B. Provide thermal infrared scan of the enclosed switches rated 200 Amps or larger under full load prior to testing / maintenance and modifications and of the modified and new switchboard sections after construction as directed and witnessed by Owner. Make corrections as needed as soon as possible as directed by the Owner. Repeat the scan at the 11-month prior to closeout, and make corrections prior to closeout. Provide digital video documentation with test results for comparison between prior condition and post construction modifications and future tests.

END OF SECTION 26 2425

SECTION 26 2430 - FUSES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Fuse work as shown and scheduled, and as specified.
- B. Types: Fuses required for the project include the following:
 - 1. 250 volt current limiting fuses
 - 2. 600 volt current limiting fuses

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Provide products produced by Bussman or Littlefuse.

2.2 CURRENT LIMITING FUSES - 600 VOLTS AND LESS

- A. General: Provide 200,000 amperes interrupting capacity (AIC) current-limiting fuses of the current ratings shown and voltage rating equal to or greater than the voltage at the point of application.
- B. Types:
 - 1. Fuses in circuits supplying individual motors, groups of motors, or loads including motors, 600 amperes or less, shall be UL Class RK1 or Class J, time delay fuses, Bussman LPS-RK (600V) LPJ-SP (600V), LPN-RK (250V).
 - 2. Fuses in circuits supplying individual motors, groups of motors, or loads including motors, 601 to 4000 amperes, shall be UL Class L time delay fuses, Bussman KRPC "HI-CAP".
 - 3. Fuses in circuits supplying other than motor loads, 600 amperes or less, shall be UL Class RK1, time delay fuses, Bussman LPS-RK (600V), LPN-RK (250V).
 - 4. Fuses supplying surge protection devices (SPD) shall be surge rated for use with SPD devices.

2.3 SPARE FUSES

- A. General: Provide spare fuses in the amount of 10% of each type and size installed, but not less than 3 spares of a specific size and type. Deliver to the Owner at the time of project acceptance. Fuses shall be encased in a labeled steel enclosure with padlock provision, to be wall mounted where directed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install fuses in fuse holders immediately before energizing of the circuit where the fuses are installed. Fuses shall not be installed and shipped with equipment.
- B. Labels: Place fuse identification labels, showing fuse size and type installed, inside the cover of each switch.

END OF SECTION 26 2430

SECTION 26 2773 - LINE VOLTAGE WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide wiring device work as shown, scheduled, indicated, and specified. Low voltage and/or digital control switches required for lighting controls and lighting control systems shall be as specified and required for the low voltage and / or digital control lighting system. Refer to drawings or other specification sections for low voltage / digital lighting control systems. Cover plates for lighting control systems shall be as specified in this section unless specifically required otherwise by the low voltage / digital control device bulkhead or form factor.

1.2 QUALITY ASSURANCE

- A. UL Label: Wiring devices shall be UL labeled.
- B. NEMA Standard WD1 and WD6.
- C. Fed. Spec. WC596, W-S-896

1.3 SUBMITTALS

- A. Mark up a complete copy of the specification section for the product to indicate a) acknowledgement of the specification requirement (Comply), or b) acknowledgement that the particular specification requirement does not apply to this specific project (Not Applicable) or, c) acknowledgement that the specification requirement cannot be made or that a variance is being submitted for review to the Architect/Engineer/Owner (Does Not Comply, Explanation:) Do not submit an outline form of compliance, submit a complete copy of the specification section with the product data.
- B. Submit a sample of each style and color of 120-Volt duplex receptacle and each 120/277-Volt switch with related cover plate. Attach plate to wiring device and label back side of plate with job description with permanent black marker.
- C. Submit manufacturer's product data sheet for each style of device and plate on the project.
- D. Submit drawings of plans, elevation and sections of receptacles and outlets in casework, cabinetwork and built-in place furniture. Coordinate dimensions with millwork shop drawings and related architectural drawing series.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Toggle switches, straight blade and twist lock devices, interior cover plates:
 - 1. Leviton
 - 2. Hubbell
 - 3. Pass and Seymour
 - 4. Eaton
- B. Dimming
 - 1. Leviton
 - 2. Lutron

2.2 WIRING DEVICE COLOR

- A. Device color shall be gray except 20A, 125V receptacles and toggle wall switches which are directly supplied from an emergency source shall be red, and heavy duty 30 Amp and larger simplex devices which shall be black in color where the building standard color is not available. Provide equivalent hospital grade devices where red is not available in grade specified. Verify with Owner / Architect prior to submitting for approval. Color change kits as required for dimming switches. Low voltage lighting control devices specified elsewhere shall match the line voltage wiring device color specified in this section.

2.3 RECEPTACLES

- A. Industrial or hospital grade tamper resistant smooth face duplex receptacles, 2 pole, 3 wire grounding, with ground connection and poles internally connected to mounting yoke, with metal mounting straps, locking plug-tail or back and side wired with screw type terminals, NEMA indicated, (X=color designation).
1. 20A, 125V duplex NEMA #5-20R: Leviton #5362-SGX
 2. 20A, 125V isolated ground duplex NEMA #5-20R: Leviton #5362-IGX
 3. 20A, 125V ground fault circuit interruption (GFCI) NEMA #5-20R weather and tamper resistant: Leviton #G5362-WTX
 4. 20A, 125V weather resistant (WR), tamper resistant: Leviton #TWR20-GY
 5. 20A, 125V plug load control, split circuit marked for "controlled", tamper resistant: Leviton #TDR20-S1G
 6. 15A, with 20A feed-through, NEMA #5-15R, 125V duplex, arc fault (AFCI), tamper resistant: Leviton #AFTR1-HGX
- B. Heavy-Duty Simplex: Single heavy-duty type receptacles, with green hexagonal equipment ground screw, with metal mounting straps, back or side wiring, black molded phenolic compound.
1. 15-60A, 125-250V, straight blade, NEMA configuration as indicated or as required by Owner.
 2. 15-50A, 125-480V, twist lock, NEMA configuration as indicated or as required by Owner.

2.4 WALL SWITCHES

- A. Toggle: Industrial grade flush toggle switches, with mounting yoke insulated from mechanism, equipped with plaster ears, switch handle, back and side-wired screw terminals.
1. Single-pole, 120/277V, 20A switch: Leviton #1221-2X
 2. Double pole 120/277V, 20A switch: Leviton #1222-2X
 3. Three-way, 120/277V, 20A switch: Leviton #1223-2X
 4. Four-way, 120/277V, 20A switch: Leviton #1224-2G
 5. Pilot light single-pole, 120/277V, 20A switch: Leviton #1221-PL
 6. Momentary, 120/277V, 20A, single-pole double throw, center off: Hubbell only, #HBL 1557G
- B. Rotary key operated switch (verify manufacturer and keying with Owner prior to construction).
1. Single-pole, 120/277V, 20A key operated switch: Leviton #1221-KL
 2. Two-pole, 120/277, 20A key operated, Leviton #1222-2KL.
 3. Three-way, 120/277V, 20A key operated switch: Leviton #1223-3KL
 4. Four-way, 120/277V, 20A key operated switch: Leviton #1224-4KL

5. Key switches shall be all keyed alike to match the Owner's standard key system. Leviton #WS-35 or as otherwise directed by Owner.

2.5 GFCI – GROUND FAULT CIRCUIT INTERRUPTER, BLANK FACE

- A. 20A, 125V, GFCI, switch rated, blank face feed through, Hubbell #GFBF20GYL, gray finish, stainless steel cover plate black laser engraved with device protected, (example: DRINKING FOUNTAIN GFCI).

2.6 INTERIOR WALL COVER PLATES AND FASTENERS

- A. High impact nylon, smooth finish, plate and screw color shall match wiring device color (also required for wall box device cover plates for low voltage and digital lighting controls specified elsewhere).
- B. Cover plate laser plate engraving for device identification (other than low voltage lighting controls).
 1. Provide laser cover plate engraving with black filling for all wiring devices indicating panelboard name, circuit, and voltage.
 2. Wiring devices connected to emergency/stand-by generator or inverter shall include the word "EMERGENCY".
 3. Text orientation shall be upright, readable from left to right when cover plate is installed.
 4. Remotely located lighting switches shall also indicate the room or area and zone controlled by each switch. Coordinate specific wording with Owner/Architect.
 5. Blank face GFCI cover plates shall also intuitively indicate the load or equipment served, device, or area protected downstream ("EDF" for drinking fountains, "RM RECEPPTS", "HOOD RECEPPTS", "VENDING", "REFRIG", etc.) For other loads, Owner/Architect shall determine name plate wording.

2.7 EXTERIOR COVER PLATES

- A. Thomas & Betts CK Series, cast aluminum standard depth, locking mount, while-in-use, wet location, universal configuration.
 1. Vertical mount receptacle: #CKSUV
 2. Horizontal mount receptacle: #CKMU
 3. Two-gang: #2CKU
 4. 30-60 Amp Devices: #CKLSUV

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Cover plates for receptacles and toggle switches shall be of the same manufacturer throughout unless otherwise noted.
 1. Key switches and keys shall be as specified and also as approved by Owner.
 2. Submit samples for each specified toggle switch and duplex receptacle color to Architect.
- B. Install wiring devices where shown and as required, in accordance with manufacturer's written instructions, requirements of NEC, and in accordance with industry practices. Do not install devices until wall construction and wiring is completed.
- C. Install receptacles and switches only in electrical boxes that are clean, free from building materials, debris, and similar matter.

- D. Install wiring devices plumb and aligned in the plane of the wall, floor, ceiling or equipment rack.
- E. Install switches in boxes on the strike side of doors as hung. Install so the up position will close the circuit or will be the highest level of illumination. Where more than one switch is in the same location, install switches in a multi-gang box with a single cover plate.
- F. Provide a cover plate for every wiring device and blank cover plates for unused rough-in-only boxes that matches the building standard. Fasten all plates outdoors with type 302 Allen Head "tamper-proof" screws.
- G. Mounting heights of all wiring devices shall comply with local accessibility standards and local codes, except where wiring devices are indicated for special purpose and access is only required by maintenance or service personnel.
- H. Refer to Architectural drawing and elevations, etc. for exact location of wiring devices. Coordinate location of all wiring devices with other trades, specialty items, and millwork and resolve all conflicts prior to rough-in. Field coordinate exact mounting location with all trades to avoid and resolve conflicts during construction.
- I. Locate receptacles for electric drinking fountains/coolers and bottle fill stations below equipment so that the receptacle is accessible and concealed as much as practical from public view by the equipment open cowling so that the receptacle remain readily accessible. For dual level basin equipment, locate receptacle under the upper basin.
- J. Provide convenience outlet receptacle within 25-feet of all new electrically operated mechanical equipment.
- K. Where exterior receptacles are intended for continuous use, mount in horizontal position with while in use cover plate. (Exterior electric drinking fountains, ice makers, ice storage bins, landscape lighting low voltage transformers, seasonal decorative lighting, etc.)
- L. Install wall box dimmers to achieve full rating specified after de-rating for ganging as recommended by manufacturer.
- M. Do not share neutral conductor on load side of dimming switches.
- N. Install receptacles with grounding pole down, or as directed by Owner. If installed horizontally, install with neutral pole on top.
- O. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- P. Provide pigtail to each receptacle and each switch. Neutral and phase conductors shall be installed using side or rear entry lugs only. Do not wrap conductors around screw terminals. Tighten all screws and lugs as recommended by manufacturer.
- Q. All receptacles and switches shall have a minimum of two wraps of Scotch 33 or equivalent tape around terminal screws.
- R. Provide toggle switch within sight of all trap primers, circulation pumps, 120-Volt motors and motorized equipment to serve as the equipment disconnect switch.

3.2 GROUND FAULT PROTECTION FOR PERSONELL

- A. When GFCI personnel protection receptacles are not commercially available or cannot be installed at a readily accessible location or indicated otherwise on the drawings, GFCI personnel protection shall be provided by a remote blank face GFCI wiring device or by an up-stream GFCI receptacle that also provides downstream GFCI protection and located in a readily accessible location. When branch circuit breaker device with integral GFCI protection is required or specified, it shall be within the manufacture's recommended distance limitations of the connected receptacle(s) or load(s) for proper GFCI personnel protection at the farthest outlet.
- B. GFCI personal protection locations include but are not limited to the following:
1. For other than dwelling units: All single phase 125-250-Volt (150-Volts to ground or less) receptacles 50-Amperes or less, and all three phase 125-250-Volt (150-Volts to ground or less) receptacles 100-Ampres or less in the locations indicated below.
 2. Dwelling units: All single phase 125-250-Volt receptacles installed in the following locations indicated below.
 3. Provide personnel GFCI protection as indicated above in the following locations and all additional locations as required by the NEC.
 - a. Outdoors (with exceptions for not readily accessible receptacles with dedicated branch circuits for snow melting, deicing, pipeline/vessel heat receptacles. Provide these loads with 30mA EGFI circuit breaker protection).
 - b. Bathrooms/toilets/restrooms
 - c. Janitors/custodial closets and mop sinks.
 - d. Laundry areas
 - e. Parking structures, service garages, garages and accessory buildings
 - f. Basements, crawl spaces (including 120-Volt lighting)
 - g. Within 6-feet of all water sources including sinks, mop-sinks, lavatories, bathtubs, shower stalls, faucets, eye wash stations, emergency shower stations
 - h. Indoor damp and wet locations
 - i. Locker rooms
 - j. Indoor swimming pools and natatoriums areas and adjacent corridor/hall convenience receptacle outlets located within 25-feet of all access doors.
 - k. Non-dwelling unit therapeutic tubs/pools/whirlpool areas and adjacent corridor/hall convenience receptacle outlets located within 25-feet of all access doors.
 - l. Receptacles serving dwelling unit kitchen counter tops
 - m. Vending machines
 - n. Elevators, dumb waiters, escalators, moving sidewalks: receptacles in pits, hoist ways, well ways or those mounted on the cars of elevators and dumb waiters.
 - o. Electric vehicle charging equipment.
 - p. All receptacles serving kitchen or food preparation counter tops.
 - q. Automotive vacuum machines
 - r. Drinking water fountains/coolers and bottle fill stations
 - s. Corded high-pressure spray washing machines
 - t. Tire inflation machines
 - u. Dish washers
 - v. Receptacles at end of cord reels or drop cords.
 - w. Boat houses, boat hoist, and all pier/dock receptacles and lighting (excludes shore power that requires GFPE).
 - x. Central plant, mechanical rooms and electrical rooms
 - y. Wood, metal, or other material fabrication or vocational training shops.
 - z. Receptacles that serve educational science and science prep room counter tops.

- C. Where a GFCI protected receptacle outlet is required or indicated behind vending machine, refrigerators or other equipment, provide remote GFCI blank face in same room as protected receptacle and at a readily accessible location with standard receptacle outlet behind equipment. Refrigerators shall be GFCI protected only where located within 6-feet of power cord distance from the edge of a sink to the surface of the refrigerator.
- D. Unless indicated otherwise, locate blank face GFCI device near light switches at same height as light switches or ganged with the light switch. Provide GFCI protection for all receptacle outlets located below 42-inches in all infant through 2-year old day care and similar areas designated for occupancy by infant through 2-year old day care occupants so the GFCI device can easily be intentionally tripped or tested and reset.
- E. Provide branch circuit breaker 30mA (EDP) or 100mA (EPE) equipment protection for utilization equipment as required by the NEC and where indicated on the drawings.

3.3 TESTING

- A. Before energizing, check for continuity of circuits, short circuits, and grounding connections.
- B. After energizing, check wiring devices to demonstrate proper operation and receptacles for correct polarization, voltage and phase orientation if intended 3-phase equipment is phase orientation dependent for proper motor rotation or operation.
- C. Test each individual GFCI receptacle and all downstream receptacles protected by an upstream GFCI device with simulated ground fault tester, make corrections as necessary.
- D. Operate each wall switch with circuit energized and verify proper operation.

END OF SECTION 26 2773

SECTION 26 2900 - MISCELLANEOUS ELECTRICAL CONTROLS AND CONTROL WIRING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Miscellaneous electrical equipment, controls, and control wiring work is as shown and scheduled, and as specified.
- B. Types: Miscellaneous electrical equipment, controls and control wiring specified in this Section include, but are not limited to, the following:
 - 1. Miscellaneous Electrical Controls:
 - a. Photo Sensors
 - b. Time switches.
 - 2. Miscellaneous Control Wiring:
 - a. Stop-start stations and inter-connecting and interlock wiring for motors, controllers, air-cooled condensing units, interlocks, safety devices, and similar items, and additional control wiring and safety devices as shown and specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND EQUIPMENT

- A. Refer to drawings.

2.4 WIRING AND RACEWAYS

- A. Line Voltage Control Wiring: As specified in Section 26 05 19.
- B. Low Voltage Control Wiring: As specified in Section 26 05 19, except that conductors shall consist of a multi-conductor jacketed cable whenever possible.
- C. Raceways: Raceways for line voltage and low voltage control wiring shall be as specified in Sections 26 05 19 and 26 05 37.

PART 3 - EXECUTION

3.1 INSTALLATION OF MISCELLANEOUS ELECTRICAL CONTROLS

- A. Install miscellaneous electrical equipment and control devices as required, in accordance with NECA Standard of Installation, and industry practices.
- B. Conductors: Connect electrical conductors to miscellaneous electrical control devices in accordance with equipment manufacturer's written instructions and wiring diagrams. Wherever possible match conductors of the electrical enclosures as shown. Ensure they are complete, including control wiring and devices.
- C. Photo Sensor and time switch settings shall be as directed by the Owner.
- D. Line and Low Voltage Control Wiring: Line and low voltage control wiring shall be installed in a suitable raceway.
- E. Connections: Refer to Section 26 05 35 for connections to equipment.

END OF SECTION 26 2900

SALAS O'BRIEN MISCELLANEOUS ELECTRICAL CONTROLS AND CONTROL WIRING

26 2900-1

Salas O'Brien Registration #F-4111

SECTION 26 4300 - SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION/SCOPE

- A. The Surge Protection Device (SPD) covered under this section includes all service entrance type surge protection devices suitable for use as Type 1 or Type 2 Devices per UL1449 4th Edition, applied to the line or load side of the utility feed inside the facility. The unit shall be connected in parallel with the facility's wiring system. The unit shall be manufactured in the USA by a qualified manufacturer of suppression filter system equipment, which has been engaged in the commercial design and manufacture of such products for a minimum of five years.
- B. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to finish and install surge protection devices.

1.2 QUALITY ASSURANCE

- A. Reference Standard: Comply with the latest edition of the applicable provisions and recommendations of the following, except as otherwise stated in this document:
 - 1. UL 1449 Fourth Edition
 - 2. ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
 - 3. ANSI/IEEE C62.45, Guide for Surge Testing for equipment connected to Low-Voltage AC Power Circuits.
 - 4. IEEE 1100 Emerald Book.
 - 5. National Fire Protection Association (NFPA 70 (NEC), 75, and 78).
 - 6. UL 1283 – Electromagnetic Interference Filters

1.3 SUBMITTALS

- A. Submit shop drawings complete with all technical information unit dimensions, detailed installation instructions, maintenance manual, and wiring configuration.
- B. Copies of Manufacturer's catalog data, technical information and specifications on equipment.
- C. Copies of documentation stating that the Surge Protection Device is listed from a Nationally Recognized Testing Laboratory (NRTL) (UL, ETL, etc.) and are tested and multi-listed to UL 1449 4th Edition and UL 1283.
- D. Copies of actual let through voltage data in the form of oscilloscope results for both ANSI/IEEE C62.41 Category C3 (combination wave) and B3 (Ring wave) tested in accordance with ANSI/IEEE C6245.
- E. Copies of test reports from a recognized independent testing laboratory, capable of producing 200kA surge current waveforms, verifying the suppressor components can survive published surge current rating on both a per mode and per phase basis using the ANSI/IEEE C62.41 impulse waveform C3 (8 x 20 microsecond, 20kV/10kA). Test data on an individual module is not acceptable.
- F. Copy of warranty statement clearly establishing the terms and conditions to the building/facility owner/operator.

- G. Provide detailed marked-up copy of this specification with line-by-line compliance or exception statements to all provisions of this specification.

1.4 WARRANTY

- A. The manufacturer shall provide a minimum 20-year warranty for high and very high exposure SPDs, a minimum 15-year warranty for all medium exposure SPDs, and a minimum 10-year warranty for all other SPDs for parts from date of substantial completion against failure. Contractor shall install in compliance with applicable national / local electrical codes and the manufacturer's Installation, Operation and Maintenance Instructions. Contractor shall assist the Owner with manufacturer warranty registration.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURER

- A. Low exposure, minimum 10-year parts warranty, minimum 50k Amps per mode, 100k Amps per phase, Type 1 and Type 2.
 - 1. Recessed mount panelboard extension with brushed stainless-steel front:
 - a. ACT Communications:471- ###V-050-SS-F-PB flush series.
 - b. Current Technology PX3-050-VVV- #X-SF-X-F- # series.
 - c. PSP Hurricane HxC100-4XN-S-F series.
 - d. SSI Surge Suppression, Inc. CSMx12-FMPxSS series.
 - 2. Branch panelboard surface mounted:
 - a. ACT Communications 455 series.
 - b. Current Technology CGC50 series.
 - c. PSP Hurricane HxC100-4XH-S series.
 - d. SSI Surge Suppression, Inc. CSMx12 series.
- B. Medium exposure, minimum 15-year parts warranty, minimum 120k Amps per mode, 240k Amps per phase, Type 2.
 - 1. ACT Communications 471 series.
 - 2. Current Technology CGP120 series.
 - 3. PSP Hurricane HxC300-4NT1-S series.
 - 4. SSI Surge Suppression, Inc. CSMx24 series.
- C. High exposure, minimum 20-year parts warranty, minimum 200k Amps per mode, 400k Amps per phase, Type 2 SPD.
 - 1. ACT Communications 471 x200 series.
 - 2. Current Technology TG 200 series.
 - 3. PSP Hurricane HxC400-4NT1-S series.
 - 4. SSI Surge Suppression, Inc. CHLxM series.
- D. Very high exposure at service entrance 1,201 Amps and above:
 - 1. ACT Communications 471 SEL series.
 - 2. Current Technology SEL3 200 series.

The service entrance protector shall incorporate a combination of TPMOV and Selenium technology allowing for transient surge and temporary over voltage protection. The unit shall be able to prevent common temporary over voltages and high impedance faults from damaging the MOVs, increasing their longevity and ability to protect the critical load. Limited and Intermediate current TOVs can be caused by a loss of the neutral conductor in a split phase or three phase power system. The available fault current will be determined by the impedance of the loads connected to the phases opposite the SPD and are typically in the range of 30A to 1000A. Minimum 20-year parts warranty,

extended over-voltage protection, minimum 200k Amps per mode, 400k Amps per phase, Type 2 SPD. The Selenium elements must limit voltage to the MOV as a percent of nominal as outlined below:

Overvoltage seen by MOVs as % of Nominal				
	available current			
time	30A	100A	500A	1000A
1 cycle	120%	130%	150%	160%
10 cycles	130%	150%	160%	160%
30 cycles	140%	150%	160%	160%

*To verify damage to the MOVs has been mitigated, the percent overvoltage seen at the MOV must be less than 200% for split-phase applications or 173% for three-phase applications (100% is nominal).

2.2 MANUFACTURED UNITS / ELECTRICAL REQUIREMENTS

- A. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449, section 37.7.3. MCOV values claimed based on the component's value or on the 30-minute 115% overvoltage test in UL1449 will not be accepted.
- B. Unit shall have not more than 10% deterioration or degradation of the UL1449, Voltage Protection Rating (VPR) due to repeated surges.
- C. Protection Modes SVR (6kV, 500A) and UL1449 VPR (6kV, 3kA) for grounded WYE/delta and High Leg Delta circuits with voltages of (480Y/277), (208Y/120), (600Y/347). 3-Phase, 4 wire circuits, (120/240) split phase shall be as follows and comply with test procedures outlined in UL1449 section 37.6: Values Depicted are based on a system Without Disconnect / With Disconnect

System Voltage	Mode	MCOV	C3 Wave	UL 1449 VPR Rating
120/240	L-N	150	650/775	700/800
120/208	L-G	150	650/825	700/900
	N-G	0	500/500	900/1000
	L-L	300	950/1250	900/1200
277/480	L-N	320	1125/1225	900/1200
	L-G	320	1075/1225	1200/1200
	N-G	0	900/900	1200/1500
	L-L	550	1950/2200	1800/1800

- D. Electrical Noise Filter- each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric noise shall be as follows using the MIL-STD-220A insertion loss test method.
 - 1. 14 dB from 10 kHz to 1 MHz.
- E. Each Unit shall provide the following features:
 - 1. Phase Indicator lights, Form C dry contacts, counter and audible alarm.
 - 2. Field testable while installed.
 - 3. High performance interconnecting cable.
 - 4. The UL 1449 Voltage Protection Rating (VPR) shall be permanently affixed to the SPD unit.
 - 5. The UL 1449 Nominal Discharge Surge Current Rating shall be 20Ka
 - 6. The SCCR rating of the SPD shall be 200kAIC without requiring an upstream

- protection device for safe operation.
7. The unit shall be listed as a Type 2 SPD per UL1449.
 8. Power wiring: SPD shall be equipped with mechanical lugs that can accept up to #2 AWG wire on High Exposure units and up to #6 on Medium and Low Exposure units

2.3 POWER CABLES FOR CONNECTION

- A. Power wiring: Conductors between all SPDs and switchgear shall be high performance interconnect system "Low Z Cable" cables with Ultra Low impedance characteristics at 10kHz and above.
- B. Low Impedance cable shall be #6 AWG minimum for Very High, High, and Medium Exposure SPDs and #10 AWG minimum for Low Exposure SPDs.

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

- A. The unit shall be installed as close as practical to the facility's wiring system in accordance with applicable national/local electrical codes and the manufacturer's recommended installation instructions. Connection shall be with high performance, low impedance cables in conduit and shall not be any longer than necessary, avoiding unnecessary bends. Minimum wire size and overcurrent protection shall be provided and as indicated or recommended by the manufacturer.
- B. Units specified for lighting and appliance panel boards as panelboard extensions (EGPE) shall be mounted directly above or below the first section of the panel board it is protecting. Any other mounting location will not be acceptable and shall be corrected, without exception, at no additional cost to the Owner.
- C. Units specified for panelboards, switchboards, or motor control centers shall be mounted directly above or adjacent to the panelboard, switchboard or motor control center using unistrut supports secured to structure as required. Conduit length between power distribution panelboard or switchboard shall be less than two inches. Mounting above equipment is not acceptable.
- D. Overcurrent device and conductors for devices shall be the maximum recommended by the manufacturer. Manufacturer's recommendations shall prevail over the information given in the plans and specifications.
- E. Provide recessed mounted panelboard extension type enclosures for devices protecting recessed panelboards. Enclosure front shall match panelboard front. Provide brushed stainless-steel front at kitchens and food processing areas.

3.2 UNIT SELECTION BASED ON EXPOSURE LEVEL

- A. (SPDVH) Provide very-high exposure SPDs with Selenium and TPMOV technology for the following new electrical equipment and where also indicated:
 1. Service entrances 1,201 Amps and above.
- B. (SPDH) Provide high exposure SPDs for the following new electrical equipment and where indicated:
 1. Service entrances 801 – 1,200 Amps

- C. (SPDM): Provide medium exposure SPDs at the following new electrical equipment and where otherwise indicated
 - 1. Service entrances 401 - 800 Amps.
 - 2. Panelboards 601 - 1,200 Amps.
 - 3. Motor control centers 601 Amps and above.
 - 4. Non-service entrance switchboards located outside.

- D. (SPDL): Provide low exposure SPDs at the following new electrical equipment and where indicated
 - 1. Service entrances 400 Amps and below.
 - 2. Panelboards 600 Amps and below.
 - 2. Motor control centers 600 Amps and below.

3.3 TESTING

- A. Factory Trained Representative shall provide start-up to include initial verification of proper installation and initiate factory warranty. The technician will be required to do the following as a minimum:
 - 1. Verify overcurrent device rating
 - 2. Verify all wiring connections and installation conforms to manufacturer's recommendations.
 - 3. Record information for each product installed and include in O&M Manual

- B. A copy of the Factory diagnostic test report and written approval of the installation shall be included with the Electrical Operating and Maintenance Manual. The Contractor shall make all adjustments, changes, corrections, etc. as required by the Factory Trained Representative so that the installation follows the manufacturer's installation and operation instructions without additional charge to the Owner.

END OF SECTION 26 4300

SECTION 26 5113 - LIGHTING FIXTURES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Work Included: Lighting fixture work is as shown, scheduled and specified.
- B. Applications: The applications of lighting fixtures required for the project include the following:
 - 1. General lighting
 - 2. Emergency lighting
 - 3. Outdoor area lighting

1.2 QUALITY ASSURANCE

- A. Provide interior building LED fixtures that comply with the Design Lights Consortium (DLC) standards and are DLC or DLC Premium listed as a Qualifying Product at time of proposal submittal date.
- B. UL Standards: Lighting fixtures shall conform to applicable UL standards, and be UL or ETL labeled.
- C. Light fixtures shall conform to the requirements of NFPA 101, and 70 (NEC).

1.3 SUBMITTALS

- A. Submit product data for light fixtures, and emergency lighting equipment, including generator transfer devices.
- B. Specification Compliance Review: Mark up a complete copy of the specification section for the product to indicate a) acknowledgement of the specification requirement (Comply), or b) acknowledgement that the particular specification requirement does not apply to this specific project (Not Applicable) or, c) acknowledgement that the specification requirement cannot be made or that a variance is being submitted for review to the Architect / Engineer / Owner (Does Not Comply, Explanation:.) Do not submit an outline form of compliance, submit a complete copy with the product data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers: Provide products produced by manufacturers shown or scheduled for each type of lighting fixture.
 - 1. Light fixtures:
 - US LED
 - Extra Light
 - Acuity
 - Hubbell
 - Signify
 - Cooper Lighting Solutions
 - Pinnacle
 - HE Williams
 - GE Current
 - 2. LED Drivers:

- Philips
- Osram Optotronic
- Eldo LED
- 3. Emergency Battery Packs with self-testing drivers/inverters:
 - Bodine
 - Chloride
 - Lithonia
 - Dual Lite
 - IOTA
- 4. Emergency Generator/Inverter Load Control Bypass Relay (ELC); UL924 listed and 0-10Vdc compatible:
 - Bodine
- 5. Emergency Generator / Inverter Branch Circuit Transfer Switch, UL 1008 listed and 0-10Vdc compatible:
 - Bodine GTD20A

2.2 MATERIALS AND COMPONENTS

- A. General: Provide lighting fixtures of the size, type, and rating indicated, with all accessories for a complete aesthetic installation.
- B. Fixture Types:
 - 1. General:
 - a. LED Lay-in edge lit or back flat panel / troffer fixtures: Opaque, edge or back lighted, 4000 Kelvin color temperature. 0-10 Vdc dimmable, L70: 60,000 minimum hours.
 - b. Safety chains and wire guards at fixtures in mechanical and electrical rooms, and high abuse areas. Provide safety chains only for gymnasium fixtures which shall be inherently vandal proof, no wire guards.
 - c. Fixtures located outdoors, in interior unconditioned spaces, and in wet locations shall be of aluminum construction.
 - d. Fixtures with door frames shall be of aluminum construction, white finish where located in kitchens, food prep areas, toilets, restrooms, locker rooms, dressing rooms, showers, and unconditioned spaces.
 - e. DLC, DLC Premium or Energy Star qualified unless specified otherwise.
 - f. Warranty: 2x2 and 2x4 lay-in light fixtures: 5-year fixture warranty for fixture, driver, and light engine. All other light fixtures: 5-year replacement warranty for fixture, driver, and light engine.
 - g. Outdoor fixtures shall include a discrete / replaceable surge suppression device in addition to the surge suppression incorporated in the LED driver.
 - h. Operating temperature rating shall be between -40 degrees F and 120 degrees F.
 - i. Color Rendering Index (CRI): ≥ 80 Indoor; ≥ 65 Outdoor
 - j. The manufacturer shall have performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows: High Temperature Operating Life (HTOL), Room Temperature Operating Life (RTOL), Low Temperature Operating Life (LTOL), Powered Temperature Cycle (PTMCL), Non-Operating Thermal Shock (TMSK), Mechanical Shock Variable Vibration Frequency, and Solder Heat Resistance (SHR).
 - 2. Downlight Fixtures: Provide recessed downlight fixtures with trim rings compatible with the ceiling material where fixture is to be installed.
 - 3. LED Exit Signs: Provide red lettering unless directed otherwise by Owner. The exit lighting fixtures shall meet the requirements of Federal, State, and Local Codes.

- a. Gymnasiums, locker rooms, athletic/PE wing and associated corridors, black box theaters, auditorium stages, cafeteriums and kitchens: Vandal resistant, wet location cast aluminum with polycarbonate protective cover exit signs, Lithonia Extreme Series.
 4. Emergency Lighting Units: Lead Calcium batteries with self-diagnostics. Provide full light output at 90 minutes of battery operation. LED lamps.
 5. Gymnasium light fixtures, glass or acrylic refractors or lenses, round profile, single point swivel pendant or hook mounting, designed to be vandal proof without the need for wire guards, no wire guards.
- C. LED drivers:
1. NEMA 410 compliant for in-rush current.
 2. Starting Temperature: -40° F [-40° C].
 3. Input Voltage: 120 to 480 ($\pm 10\%$) V.
 4. Power Supplies: Class I or II output.
 5. Surge Protection: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 x 50 μ s, 10kA/8 x 20 μ s) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
 6. Power Factor (PF): ≥ 0.90 .
 7. Total Harmonic Distortion (THD): $\leq 20\%$.
 8. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
 9. Drivers shall be reduction of hazardous substances (ROHS)-compliant.
- D. Voltage: Equipment for use on 120V systems shall be suitable and guaranteed for voltage range of 100V to 130V. Equipment on 277V systems shall be suitable and guaranteed for voltage range of 225V to 290V. Universal voltage equipment shall be suitable and guaranteed for a voltage range of 100V to 290V.
- E. Light fixture housing for exterior use: Provide aluminum or stainless housing. Where stainless steel hardware is used, both male and female fasteners shall be stainless steel.
- F. Emergency LED battery self-testing drivers and inverters; 5-year warranty. Basis of Design:
1. Bodine BSL-ST Series for OEM installation
 2. Bodine BSL310-SI Series for field installation
 3. Bodine ELI-S Series for line voltage sine wave inverter field installation
- G. Emergency Battery Packs – Exit Signs: Nickel Cadmium battery with self- diagnostics; Minimum 3-year non-prorated replacement warranty.
- H. Emergency Generator / Inverter Load Control Device (ELC):
1. 16 Amp minimum ballast / driver load
 2. Compatible with 0-10 Volt dimmer switches
 3. UL 924
 4. Minimum 3-year warranty
 5. Integral or remove test switch.
- I. Emergency Generator / Inverter branch circuit transfer switch:
1. UL 1008
 2. 20 Amp ballast/driver load
 3. 0-10Vdc dimming compatible

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install lighting fixtures of the types indicated, where shown, and at indicated heights in accordance with the fixture manufacturer's written instructions and industry practices to ensure that the fixtures meet the specifications. Fixtures shall fit the type of ceiling system scheduled.
- B. Standards: Comply with NEMA standards, applicable requirements of NEC pertaining to installation of interior lighting fixtures, and with NECA Standard of Installation.
- C. Attachment: Fasten fixtures to the indicated structural support members of the building. Provide four separate wire supports for recessed ceiling mounted lighting fixtures, one at each corner of fixture. Check to ensure that solid pendant fixtures are plumb. Provide T-bar locking clips on all four sides for lay-in fixtures.
- D. Coordination: Field coordinate and locate lighting fixtures in open ceiling areas including mechanical and electrical rooms so that light is not obstructed by piping, ductwork, etc. Locate light fixtures in front of electrical and mechanical equipment to provide adequate illumination for testing and maintenance. Relocate installed light fixtures as directed by Owner / Architect at no additional cost.
- E. Final adjustment of all aimable exterior light fixtures shall be in coordination with, and to the satisfaction of, the Owner's designated representative. Pre-aim all fixtures prior to scheduled final aiming and adjustment with Architect / Owner. Verify that all rotatable optics are in their proper orientation prior to final aiming.
- F. Provide vandal resistant exit signs without wire guards in all physical education and athletic sports areas, including egress corridors adjacent to these areas, black box theaters, auditorium stages, vocational shops, cafeteriums and kitchens.
- G. Provide exit sign directional arrows as required. Provide a minimum of two and a maximum of 10% spare exit signs to be installed as directed by Architect.
- H. Install in accordance with manufacturers instructions.
- I. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminary at indicated height.
- J. Locate recessed ceiling luminaires as indicated on the Architectural reflected ceiling plan.
- K. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prohibit movement.
- L. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure. Provide auxiliary members spanning ceiling Ts to support surface mounted luminaires. Fasten surface mounted luminaires to ceiling T using bolts, screws, rivets, or suitable clips.
- M. Install recessed luminaires to permit removal from below.
- N. Install recessed luminaires using accessories and fire stopping materials to meet regulatory requirements for fire rating.
- O. Install wall-mounted luminaires at height as directed by Architect.

- P. Install accessories furnished with each luminary.
- Q. Connect luminaires to branch circuit outlets using flexible conduit as specified.
- R. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaires.
- S. Bond products and metal accessories to branch circuit equipment grounding conductor.
- T. Provide emergency transfer devices for light fixtures powered by generator or inverter emergency lighting circuits which are used for normal lighting and to be switched with the switched normal lighting circuit in the same room, corridor or area.
- U. Provide un-switched, constant-hot circuit to all battery powered emergency lighting equipment and emergency load control devices (ELC). Where normal light fixture circuit is switched or contactor controlled, non-switched battery charging or ELC circuit shall originate from same branch circuit breaker as switched lighting circuit.
- V. Provide emergency powered light fixture in front of all electrical switchgear, including but not limited to panelboards, switchboards, motor control centers, low voltage control panels, transfer switches, motor controllers and disconnect switches.
- W. Provide emergency battery operated light fixtures at all transfer switch locations and at all central battery emergency lighting inverters.
- X. Provide automatic controls for exterior light fixtures. Exterior building mounted light fixtures shall be circuited through lighting contactors. Lighting contactors shall be controlled by the Building Management System. Provide separate lighting contactors for:
 - 1. Parking Lot Lighting
 - 2. Building Mounted Lighting
 - 3. Exterior Signage
- Y. Lighting contactors shall not be installed above ceiling and shall be readily accessible, located in same room as panelboard serving load.
- Z. Wall mounted light fixtures shall be attached to the studs in the walls. Attachment to gypsum board only is not acceptable. Where wall mounted fixtures attach to junction box only, firmly secure junction box to adjoining studs in wall.
- AA. Lighting Fixture Supports:
 - 1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction to the structural slab or to structural members within a partition, or above a suspended ceiling.
 - 2. Shall maintain the fixture positions after cleaning and relamping.
 - 3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
- BB. Hardware for surface mounting fixtures to suspended ceilings:
 - 1. In addition to being secured to any required outlet box, fixtures shall be bolted to a grid ceiling system at four points spaced near the corners of each fixture. The bolts shall be not less than 1/4 inch secured to channel members attached to and spanning the tops of the ceiling structural grid members. Non-turning studs may be attached to the ceiling structural grid members or spanning channels by special clips designed for the purpose, provided they lock into place and require simple tools for removal.

2. In addition to being secured to any required outlet box, fixtures shall be bolted to ceiling structural members at four points spaced near the corners of each fixture. Pre-positioned 1/4-inch studs or threaded plaster inserts secured to ceiling structural members shall be used to bolt the fixtures to the ceiling. In lieu of the above, 1/4-inch toggle bolts may be used on new or existing ceiling provided the plaster and lath can safely support the fixtures without sagging or cracking.
- CC. Lighting Fixture Supports for aluminum canopies:
1. Light fixtures mounted under aluminum canopies shall be UL wet location from above listed without a protective ceiling or cover. Light fixture shall not have conduit penetrations or mounting hole penetrations field made in the top of the fixture. Conduit penetration shall be at the end of the fixture only.

3.2 TESTING

- A. General: Upon installation of lighting fixtures, and after building circuits are energized, apply electrical energy to demonstrate proper operations of lighting fixtures, emergency lighting, and controls. When possible, correct malfunctioning units at the site, then retest to demonstrate proper operation; otherwise, remove and replace with new units, and proceed with retesting.
- B. Pre-Inspection Tasks: Immediately before final inspection, clean fixtures inside and out, including plastics and glassware, adjust trim to fit adjacent surfaces, replace broken or damaged parts, and lamp and test fixtures for electrical and mechanical operations. Any fixtures, or parts of fixtures that show signs of rust or corrosion at the time of completion, shall be removed, and replaced with protected metal parts.
- C. Final aiming and Adjustment: Aim and adjust aimable and adjustable lighting fixtures for their intended purpose. Re-aim and re-adjust as required to the satisfaction of the Architect / Owner, including nighttime adjustment of exterior lighting in the presence of the Architect / Owner.

END OF SECTION 26 5113

SECTION 26 5600 - SITE LIGHTING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The extent of site lighting required is indicated on the drawings and schedules and by the requirements of this Section and Section 26 05 00 General Electrical Provisions.
- B. Poles and Standards specified in this Section are for outdoor use for the support of luminaires and include the following: Aluminum and/or steel
- C. Related Sections: Refer to other sections for the following:
 - 1. Lighting Fixtures and Lamps

1.2 QUALITY ASSURANCE

- A. Codes and Standards: Provide luminaires, poles standards and appurtenances conforming to the following:
 - 1. Conform to applicable sections of American Association of State Highway and Transportation Officials (AASHTO): LTS-1 Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.
 - 2. American National Standards Institute (ANSI):
 - a. C2 National Electrical Safety Code.
 - 3. Conform to applicable sections of American Society for Testing and Materials (ASTM)B 429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. FA 1 Outdoor Floodlighting Equipment.
 - b. OD 3 Physical and Electrical Interchangeability of Photo Control Devices and Mating Receptacles.
 - 5. Conform to applicable sections of National Fire Protection Association (NFPA) 70, National Electrical Code.
 - 6. Underwriters Laboratories, Inc. (UL):
 - 7. Design Lights Consortium (DLC)

1.3 SUBMITTALS

- A. Refer to Section 26 05 00 General Electrical Provisions. Submittal must include photometric reports, otherwise they will be rejected as incomplete.
- B. Contractor shall not rough-in, build concrete foundations, etc. for site lighting until all site lighting submittals have been approved. Contractor shall submit site lighting photometrics with product data. The review of site lighting submittals may include the relocation, addition or deletion of lighting fixtures, poles and standards due to the photometric performance of substituted manufacturers. Any changes required due to the contractor's substitution shall be at no cost to the Owner.
- C. Submittal sheets shall be sequentially numbered with the format: Sheet number of number total. Example 1 of 3
- D. Submit manufacturer's product data including the following:
 - 1. Line-by-line compliance of the specification indicating compliance or description of deviation.
 - 2. Submit a computer generated point-by-point calculations for all outside lighting.
 - 3. Dimensioned and detailed drawings in booklet form with separate sheet or sheets

for each fixture, assembled in luminaire "type" alphabetical order and showing: materials of construction; arrangement of components and wiring; gasketing for weather tightness; means of mounting luminaire and adjusting aspect; finishes; photometric data with lamp or lamps specified; electrical data including volts, amperes and watts; and for roadway type luminaires, distribution data according to Illuminating Engineering Society (IES) roadway classification type.

4. LED Driver and light engine, initial and mean lumen output, and color rendering index. LED drivers and related electrical characteristics and operating conditions.
5. Poles and standards dimensions, details of hand holes and wire entries, mast or bracket arms and connection to poles, wind load and deflection, and finishes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers acceptable contingent upon Product's compliance with the specifications: refer to Lighting Fixture Schedules on the drawings for acceptable manufacturers of light fixtures. Acceptable Pole Manufacturers: Valmont, KW, WJM.
- B. Where lighting regulations exist by the Authority Having Jurisdiction, the Contractor shall be responsible for submission of all documentation and approval from the Authority Having Jurisdiction of the exterior lighting were alternate manufacturers are proposed other than specified. Where approval from an Authority Having Jurisdiction is required, Contractor shall submit, with those product data, confirmation of approval from the Authority Having Jurisdiction.

2.2 LUMINAIRES

- A. Refer to Section 26 51 13 Lighting Fixtures and Lamps, for ballast, drivers, and lamp requirements.
- B. Provide luminaires of the sizes, type and ratings indicated, complete with housings, lenses, refractors, lamps, lamp holders, reflectors, ballasts, starters, igniters, mounting brackets or hardware with adjusting means and wiring.
- C. Provide luminaires with rigidly formed, weather and light tight enclosures that will not warp, sag, or deform in use. Provide housings free from burrs, sharp edges or corners.
- D. Provide captive hardware hinged doors, operating freely, to allow lamp installation and removal without the use of tools. Equip door mechanism to preclude accidental falling of the door when opening or closing or when secured in the closed position. Provide for door removal for cleaning or replacing lens.
- E. Provide stainless steel hinges, latches, fasteners, and hardware to prevent corrosion of hardware or the staining of adjacent surfaces.
- F. Use interior formed and supported light reflecting surfaces having reflectances of not less than 85 percent for white surfaces, 85 percent for specular surfaces, and 75 percent for specular diffuse surfaces.
- G. Use borosilicate tempered glass, lenses and refractors. Use heat and aging resistant resilient gaskets to seal and cushion lens and refractor mounting in luminaire doors.
- H. Provide finishes of the color and type indicated and having the following properties:
 1. Protection of metal from corrosion - 5 year warranty against perforation or erosion of the finish from weathering.

2. Color retention – 5-year warranty against fading, staining, or chalking from weathering, including solar radiation.
 3. Provide finish of uniform thickness and color, free from streaks, stains or orange peel texture.
- I. LED sources shall meet the following requirements:
1. Operating temperature rating shall be between -40 degrees F and 120 degrees F.
 2. Color Rendering Index (CRI): ≥ 65 .
 3. The manufacturer shall have performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows: High Temperature Operating Life (HTOL), Room Temperature Operating Life (RTOL), Low Temperature Operating Life (LTOL), Powered Temperature Cycle (PTMCL), Non-Operating Thermal Shock (TMSK), Mechanical Shock Variable Vibration Frequency, and Solder Heat Resistance (SHR).
- J. LED drivers shall meet the following requirements:
1. Drivers shall have a minimum efficiency of 85%.
 2. Starting Temperature: -40° F.
 3. Input Voltage: 120 to 480 ($\pm 10\%$) V.
 4. Power Supplies: Class I or II output.
 5. Surge Protection: The system must survive 250 repetitive strikes of “C Low” (C Low: 6kV/1.2 x 50 μ s, 10kA/8 x 20 μ s) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. “C Low” waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
 6. Power Factor (PF): ≥ 0.90 .
 7. Total Harmonic Distortion (THD): $\leq 20\%$.
 8. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
 9. Drivers shall be reduction of hazardous substances (ROHS)-compliant.

2.3 POLES AND STANDARDS

- A. Provide poles of the types and heights indicated. Provide internal raceway for underground power supply, with luminaire support pole base indicated. Provide poles that will carry the indicated supports, luminaires and appurtenances, at the required heights above grade, without excessive deflection or whipping of the luminaire when subjected to 120 mph basic wind speed with 1.3 gust factor. Pole structural integrity shall rely solely on the anchor bolts, nuts and washers. Pole shall not be in direct contact with concrete base or mortar.
- B. Provide metal lighting poles with steel or aluminum shaft; equipped for post top or mast arm luminaire mounting. Provide wiring access hand hole with welded $\frac{1}{2}$ " NC ground lug, readily accessible from hand hole opening. Provide features as follows:
1. Provide a one-piece pole shaft fabricated from a weldable grade carbon structural steel tubing with a uniform thickness as required. Material shall conform to ASTM A-500, Grade C.
 2. Provide anchor base of the same material and finish as the pole, welded to the pole. Provide adequately sized (at least 15 square inches) hand hole with screwed cover. Provide galvanized steel hold-down or anchor bolts and leveling nuts. Provide full base cover.
 3. Factory prime coat with polyester powder-coat paint. Steel poles shall be hot dipped galvanized, with prime coat, with 8 mil minimum polyester powder-coat paint. Color to match light fixture.
- C. Anchor bolts:
1. Provide zinc coated anchor bolts and nuts. Length shall be per pole manufacturer's shop drawings, complete with 3 inch right angle bend on one end

- and 6 inches of thread on the other end. Provide zinc coated flat washers, lock washers, and hexagonal nuts for each pole.
2. Provide template for positioning of anchor bolts.

D. Accessories:

1. Full base covers, finish to match pole
2. Hand hole with cover plate and vandal resistant hardware.

2.4 LUMINAIRE MOUNTING

- A. Provide corrosion resistant metal luminaire mounting compatible with the poles and fixtures that will not cause galvanic action at contact points. Provide mounting that will correctly position the luminaire to provide the required light distribution. Provide drill mounting to pole shaft unless specified otherwise.
- B. Provide brackets, cantilevered and without under brace, of the sizes, styles, and finishes indicated with straight tubular end section to accommodate the luminaire.
- C. Provide steel tenon only for single fixture yoke or spider post top mounting securely fastened to the top of the pole shaft, fabricated to accept and rigidly support the luminaire to be mounted thereon. Set screws shall have pole shaft drilled to prevent rotational movement.

PART 3 - EXECUTION

3.1 LIGHTING POLE INSTALLATION

- A. Contractor shall not rough-in conduit, drill or pour concrete foundations for site lighting until review of the site lighting submittals is complete. This is to ensure coordination with the current site plan paving and utilities and photometric performance of the submitted product.
- B. Install lighting poles as follows:
 1. Install lighting poles and standards as indicated, in accordance with manufacturer's written instructions, and in compliance with ANSI C2.
 2. Provide excavation and poured concrete bases using 3,000 pound 28-day concrete, and provide anchor hook-bolts, nuts and washers in conformance with the details and manufacturer's requirements. Refer to Division 3 for concrete work. Project anchor bolts 2-inches minimum above base. Use double nuts for adjustment.
 3. To protect finish, use fabric web slings (not chain or cable) to raise and set finished poles and standards.
 4. Install pole clear of contact of concrete base or mortar.
- C. Grounding: Provide equipment bonding and grounding connections, sufficiently tight to assure permanent and effective grounds. Bond all metal, non-current carrying parts to ground. Provide 25-foot #2 solid ground electrode from pole base hand holes encased in concrete pier, to bottom of concrete pier with excess ground electrode coiled at bottom of concrete pier. Secure the ground electrode to the reinforcement steel to prevent movement during concrete pour. Bond all metal parts of the pole shaft ground lug. Provide #6 electrode grounding conductor from pole base ground lug to the ground conductor, using thermal fusion (exothermic) methods.
- D. Wiring:
 1. Provide Type SO cord from base of pole lights to top of poles. Do not use single conductors.

2. Install inline fuse holders, fuses, at base of pole lights on each lighting circuit. Provide Bussman Insulating boot Catalog # 2A0660 installed over conductor terminations. Fuse size shall be as follows:

WATTAGE	# OF Fixtures	208V	240V	277V	480V
0-400	1	5	5	5	5
0-400	2	8	8	5	5
0-400	3	10	10	8	5
0-400	4	15	10	10	8
401-1000	1	10	8	8	5
401-1000	2	15	15	15	8

3. Provide Styrofoam wedge at midpoint of pole to stabilize conductor.
4. Provide strain/stress relief on SO cord at top of pole.

3.2 LUMINAIRE INSTALLATION

- A. Install exterior luminaires at locations and heights as indicated, in accordance with the manufacturer's written instructions, applicable requirements of NFPA 70, ANSI C2 and with recognized industry practices to ensure that lighting installation fulfills requirements.
- B. Fasten luminaires securely to indicated structural supports and check to ensure that the required degree of freedom is provided to allow alignment or aiming of the fixtures for indicated light distribution.
- C. Clean exterior luminaires of dirt and debris upon completion of installation. Do not damage finishes or lens or refractor surfaces.
- D. Provide equipment grounding connections using branch circuit equipment and connected sufficiently tight to assure a permanent and effective ground.

3.3 TESTS AND DEMONSTRATIONS

- A. Upon installation of lighting fixtures, and after building circuits are energized, apply electrical energy to demonstrate proper operations of lighting fixtures, emergency lighting, and controls. Correct malfunctioning units, then retest to demonstrate proper operation; otherwise, remove and replace with new units, and proceed with retesting. Verify correct reflector types and orientation prior to final aiming.
- B. Pre-Inspection Tasks: Immediately before final inspection, clean fixtures inside and out, including reflectors, plastics and glassware, adjust trim to fit adjacent surfaces, replace broken or damaged parts, and lamp and test fixtures for electrical and mechanical operations. Any fixtures, or parts of fixtures that show signs of rust or corrosion at the time of completion, shall be removed, and replaced with protected metal parts. Pre-aim lighting fixtures as practical prior to final aiming and adjustment.
- C. Final aiming and Adjustment: Aim and adjust aimable and adjustable lighting fixtures for their intended purpose, as specified, as indicated and/or recommended by Manufacturer's photometric report. Re-aim and re-adjust as required to the satisfaction of the Architect/Owner, including nighttime adjustment of exterior lighting in the presence of the Architect/Owner. Provide five business day notification of proposed night-time review by Owner / Architect.

3.4 LAMP REPLACEMENT AND PROVISION OF SPARE LAMPS

- A. At time of substantial completion, replace lamps in luminaires that are observed to be not functioning properly after Contractor's use and testing. Provide spare replacement non-LED lamps amounting to 10 percent (but not less than ten lamps in each case) of each type and size lamp used in each type fixture.

END OF SECTION 26 5600

SECTION 31 3116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Soil treatment.
 - 2. Wood treatment.
- B. Related Requirements:
 - 1. Section 06 1053 "Miscellaneous Rough Carpentry" for wood preservative treatment by pressure process.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
 - 2. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of termite control product.
- C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
 - 1. Date and time of application.
 - 2. Moisture content of soil before application.
 - 3. Termiticide brand name and manufacturer.
 - 4. Quantity of undiluted termiticide used.
 - 5. Dilutions, methods, volumes used, and rates of application.
 - 6. Areas of application.
 - 7. Water source for application.

- D. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
1. Date and time of application.
 2. Termiticide brand name and manufacturer.
 3. Quantity of undiluted termiticide used.
 4. Dilutions, methods, volumes used, and rates of application.
 5. Areas of application.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

1.6 FIELD CONDITIONS

- A. Soil Treatment:
1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
 2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain termite control products from single source from single manufacturer.

2.2 SOIL TREATMENT

- A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. Bayer Environmental Science; Premise 2.
 - b. Ensystem, Inc; Maxxthor SC.
 - c. Master Builders Solutions; Phantom.
 - d. Syngenta; Demon Max.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

2.3 WOOD TREATMENT

- A. Borate: EPA-Registered borate termiticide acceptable to authorities having jurisdiction, in an aqueous solution for spray application and a gel solution for pressure injection, formulated to prevent termite infestation in wood.
 1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Ensystem, Inc;](#) Borathor.
 - b. [Nisus Corporation;](#) Bora-Care.
 - c. [NovaGuard Technologies, Inc;](#) Armor-Guard.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum

specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
 3. Crawlspace: Soil under and adjacent to foundations. Treat adjacent areas, including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
 4. Masonry: Treat voids.
 5. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.
- B. Post warning signs in areas of application.
- C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.4 APPLYING WOOD TREATMENT

- A. Wood Treatment: Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.
- B. Application: Mix borate wood treatment solution to a uniform consistency. Apply treatment at the product's EPA-Registered Label volume and rate for the maximum borate concentration allowed for each specific use so that wood framing, sheathing, siding, and structural members subject to infestation receive treatment. Apply treatment where required.
1. Framing and Sheathing: Apply termiticide solution by spray to bare wood and with complete coverage.

3.5 PROTECTION

- A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

END OF SECTION 31 3116

SPECIFICATION TABLE OF CONTENTS:

420	Concrete Structures
02100	Site Preparation
02200	Earthwork
07920	Caulking and Joint Sealants
129300	Site Furnishings
312445	Decomposed Granite
328400	Planting Irrigation
329201	Hydro-mulching
329202	Sodding
329300	Plants
329301	Exterior Landscape Maintenance



ITEM 420

CONCRETE STRUCTURES

420.1 Description. This Item shall govern for the construction of culverts, retaining walls, abutments, bents, piers, girders, slabs and all other structures involving the use of concrete.

All concrete structures shall be constructed in accordance with the design requirements and the details shown on the plans; in conformity with the pertinent provisions of the items contracted for and the incidental items referred to; and in conformity with the requirements herein set forth.

420.2 General Requirements. Before starting work, the Contractor shall inform the Engineer fully as to the methods of construction he proposes to follow and as to the amount and character of equipment he proposes to use; the adequacy of which shall be subject to the approval of the Engineer. Concurrence on the part of the Engineer in any proposed construction methods and approval of equipment, shall not relieve the Contractor of the responsibility for the safety or correctness of his/her methods or the adequacy of his/her equipment or from carrying out the work in full accordance with his/her contract.

420.3 Materials. All concrete shall conform to Item 421 "Structural Concrete" or as indicated on the plans. The class of concrete for each unit shall be as shown on the plans.

Preformed expansion joint materials shall meet the requirements of ASTM D994 or ASTM D1751, as well as the Item 438 "Preformed Joint Seal".

Poured joints shall be asphalt that is homogeneous, shall be free from water and shall not foam when heated to 392° F. It shall conform to the following requirements:

Flash point (open cup), not less than 200°C (392°F)

Softening point (ring and ball method) 65°C to 110°C (149°F to 230°F)

Penetration at 0°C (32°F), 200 gms., 60 sec., not less than.....10

Penetration at 25°C (77°F), 100 gms., 5 sec.,.....30 to 50

Penetration at 46°C (115°F), 50 gms., 5 sec., not more than.....110

Loss on heating at 163°C (325°F), 50 gms., 5 hrs., not more than.....1.0%

Penetration at 25°C (77°F), 100 gms., 5 sec., of residue after heating at 163°C (325°F), as compared with penetration of asphalt before heating, not less than.....60.0%

Ductility at 25°C (77°F), not less than 3.0 cm.

Proportion of bitumen soluble in carbon tetrachloride, not less than..99.0%

Total bitumen (soluble in carbon disulphide), not less than.....99.0%

All other materials such as reinforcing steel and structural steel shall conform to the requirements of the pertinent specifications.

420.4

General Construction Requirements. Before constructing forms and falsework for concrete superstructure spans over 20 feet in length; form and falsework plans shall be submitted to the Engineer for review and approval. Similar plans shall be submitted for other units of the structure if requested by the Engineer. The plans shall be prepared on standard sheets 22 inches x 34 inches overall size and shall be sufficiently complete to show all essential details of the proposed forms, falsework, and bracing for same. In general, not over six sets of such plans will be required.

Concurrence on the part of the Engineer in any proposed construction methods, approval of equipment, or approval of form and falsework plans shall not be considered as relieving the Contractor of the responsibility for the safety or correctness of his/her methods and adequacy of his/her equipment, or from carrying out the work in full accordance with the contract.

Unless otherwise provided, the following requirements shall govern for the time sequence in which construction operations may be carried on and for the opening of completed structures to traffic.

Steel I-beams or forms and falsework for superstructures shall not be erected on concrete substructures until the concrete in the substructures has cured at least 4 curing days. Concrete for concrete slab or girder spans or concrete slabs on steel I-beam spans shall not be placed until the substructure has cured at least 7 curing days.

Steel trusses or plate girders to be erected from the ground on approved falsework may be erected when the substructure has cured 4 curing days, but the falsework shall not be removed until the substructure has cured at least 7 curing days. Erection by means of a traveling crane on the span will not be permitted until the substructure has cured at least 7 curing days.

Forms for walls or columns shall not be erected on concrete footings until the concrete in the footing has cured at least 2 curing days. Concrete may be placed in the wall or column as soon as the forms and reinforcing steel placement is approved.

The use of completed portions of a structure as the site for mixing operations or for storage of materials will not be permitted until the particular portion of the structure has aged at least ten curing days.

A curing day shall be as defined in the Section 420.24 "Removal of Forms and Falsework". In continued cold weather the construction operations may be authorized at the end of a period of calendar days equal to twice the number of curing days specified above.

For bridges and direct traffic culverts, construction traffic and traveling public permitted in accordance with the following:

- A. Authorization for light construction traffic not to exceed a three-quarter ton truck may be given after last slab of concrete has been in place at least 14 days.
- B. Authorization for normal construction traffic, when necessary, and to traveling public may be given after last slab of concrete has been in place 30 days.

Forms or screed supports for bridges may be attached to I-beams or girders by welding.

420.5 Foundations. Excavation for foundations shall be made in accordance with the requirements of pertinent specifications.

Caissons shall be constructed of the materials and to the dimensions and details shown on the plans. Forms for concrete caissons may be of wood or metal meeting the specified requirements. The operation of sinking will be permitted to proceed immediately after form removal.

Where necessary, falsework shall be provided to support the caisson during the construction and lowering period. Such falsework shall be of the strength required to support the caisson in combination with the forces of wind, water currents and drift.

Concrete foundation seals, if required, shall be of the thickness shown on the plans. The seals shall be Class D Concrete and shall be placed in accordance with the requirements herein for concrete placed in water. The completed seal shall not be higher or lower than the plan grade or the grade established by the Engineer, by more than 1/16 times the least inside caisson, cofferdam, or dredge well dimension at such grade.

The seal shall be allowed to set for at least 36 hours before the caisson or cofferdam is dewatered. After dewatering, the top of seal shall be cleaned off, all or other soft material readily loosened with a pick shall be removed, and all high spots which exceed the above limitation shall be cut off and removed.

Foundation piling shall be cut off square at the elevation shown on plans. A tolerance of not more than 2 inches above or below established cut-off grade will be permitted.

420.6 Drains. Weep hole drains shall be installed in abutments and retaining walls, and roadway drains or scuppers shall be installed in the roadway slabs in accordance with the details shown on the plans.

420.7 Expansion Joints and Devices. Expansion joints and devices to provide for expansion and contraction shall be constructed where and as indicated on the plans.

Unless otherwise provided on the plans, the bridge seat under the expansion ends of concrete slab spans and slab and girder spans shall be given a steel trowel finish, and the surfaces of substructure and spans and girders shall be separated by layers of roofing felt or a combination of roofing felt and sheet metal. Before installation, the contact areas of such roofing felt or sheet metal shall be coated with graphite grease. Layers of roofing felt or sheet metal shall be carefully placed so that concrete or mortar will not be worked around or under the material.

All joints constructed, to be left open or filled with poured joint material, shall be constructed using forms adaptable to loosening or early removal. In order to avoid jamming such forms by the expansion action of the spans and the consequent likelihood of injury to the adjacent concrete, these forms shall be removed or loosened as soon as practicable after the concrete has attained its final set. A provision for loosening the forms to permit free expansion of the span without the necessity for full removal is preferred.

Armored joints shall be carefully constructed in order to avoid defective anchorage of the steel and to avoid porous or honeycombed concrete adjacent to same.

When premolded joint material is to be used in vertical joints of roadway and sidewalk slabs, the tops of such joints shall be adequately sealed with asphalt of the quality specified for poured joint materials. To accomplish this sealing, the top 2 inch depth of the joint shall be constructed open or the premolded material shall be plowed out and the space filled with liquid asphalt.

Premolded material, if specified, shall be used in expansion or contraction joints in abutment walls, wing walls and retaining walls. Metal flashing strips for the prevention of water seepage through wall joints shall be provided and installed in accordance with the plan provisions.

Premolded materials, wherever used, shall be anchored to the concrete on one side of the joint by means of copper wire not lighter than No. 12 B. & S. gauge. Such anchorage shall be sufficient to preclude the tendency of the material to fall out of the joint.

Careful workmanship shall be exercised in the construction of all joints to insure that the concrete sections are completely separated by an open joint or by the joint materials and to insure that the joints will be true to the outline indicated. Immediately after the removal of forms and again where

necessary after surface finishing, all projecting concrete shall be removed along the exposed edges of premolded materials in order to secure full effectiveness of the expansion joint.

Where roofing felt or premolded material is specified for horizontal joints, the material shall, if practicable, extend 2 inches beyond the form for the top member. The projecting portions shall be subsequently trimmed to the face of the member after the forms are removed.

420.8 Construction Joints. The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. When concrete in a structure or a portion of a structure is specified to be placed monolithic, the term monolithic shall be interpreted to mean that the manner and sequence of concrete placing shall be such that construction joints will not be created.

Construction joints shall be of the type, location and spacing shown on the plans. Additional joints shall not be provided, without written authorization from the Engineer. Any additional construction joints shall have details equivalent to those shown on the plans for joints in similar locations.

Unless otherwise provided, construction joints shall be square and normal to the forms. Bulkheads shall be provided in the forms for all joints except horizontal joints.

The top surface of a concrete placement which terminates at a horizontal construction joint shall have the surface cement film removed and shall be thoroughly roughened as soon as practicable after the concrete has attained initial set. The surface at bulkheads shall be roughened as soon as the bulkhead forms are removed.

Before joining plastic concrete to concrete that has already set, the surface of the concrete in place shall be thoroughly cleaned up of all loose materials, dirt or foreign matter; shall be washed and scrubbed clean with stiff brooms and thoroughly drenched with water until saturated, and shall be kept wet until the plastic concrete has been placed. Immediately prior to the placing of additional concrete, all forms shall be drawn tight against the concrete in place, and the surface of the concrete in place shall be flushed with a coating of grout mixed in the proportions of one part of cement to two parts of sand.

If shown on the plans, construction joints shall be provided with concrete keyways, reinforcing steel dowels, and/or metal flashing strips. The method of forming keys in keyed joints shall be such as to permit the easy removal of forms without chipping, breaking, or damaging the concrete in any manner.

420.9 Falsework. All falsework shall be designed and constructed so that no excessive settlement or deformation will occur, and so that the necessary rigidity will be provided. Details of falsework construction shall be subject

to review and approval by the Engineer in accordance with the provisions of Section 420.4 "General Construction Requirements".

For calculating the loads on falsework, a weight of 150 pounds per cubic foot shall be assumed for concrete, and a live load allowance of 50 pounds per square foot of horizontal surface of the form work shall be included. The maximum stresses shall not exceed 125 percent of the allowable stresses used for the design of the structure.

All timber used in falsework centering shall be sound, in good condition, and free from defects which will impair its strength.

Steel members shall be of adequate strength and of such shape as to be suitable for the purpose intended.

Timber piling may be of any species of wood which will withstand driving satisfactorily and which will adequately support the superimposed load.

Where sills or timber grillages are used to support falsework columns, unless founded on, shale or other hard materials, shall be placed in excavated pits and backfilled to prevent the softening of the supporting material by drip from the forms or by rains that may occur during the construction process. Sills or grillages shall be of ample size to support the superimposed load without settlement.

Falsework which cannot be founded on a satisfactory spread footing shall be supported on piling which shall be driven to a bearing capacity sufficient to support the superimposed load without settlement. The safe bearing capacity of piling shall be determined by the formula specified elsewhere.

In general, each falsework bent shall be capped transversely at the proper elevation by a cap of adequate size. If desired by the Contractor, however, a short cap section forming a T-head may be substituted at the top of each pile or column in order to permit the removal of portions of the forms without disturbing the falsework. Caps shall be securely fastened to each pile or column in the bent and shall be set at the proper elevation to produce, in conjunction with the use of approved hardwood wedges or jacks, permanent camber indicated on the plans or specified, plus a construction camber covering allowance for deformation of the forms and falsework. The use of wedges to compensate for incorrectly cut bearing surfaces will not be permitted. Each falsework bent shall be securely braced to adjacent bents by bracing material of ample size to provide the stiffness required. The bracing shall be securely spiked or bolted to each pile or column it may cross.

420.10 Forms. Forms shall be built mortar-tight and of material sufficient in strength to prevent bulging between supports and shall be set and maintained to the lines designated until the concrete is sufficiently hardened to permit form removal. During the elapsed time between the building of the forms and the placing of the concrete, the forms shall be

maintained in a manner to eliminate warping and shrinking. All details of form construction shall be subject to the approval of the Engineer, and permission to place concrete will not be given until all of such work is complete to his/her satisfaction.

Forms shall be designed for the pressure exerted by a liquid weighing 150 pounds per cubic foot. The rate of placing the concrete shall be taken into consideration in determining the depth of the equivalent liquid. An additional live load of 50 pounds per square foot shall be allowed on horizontal surfaces. The maximum stresses shall not exceed 125 percent of the allowable stresses used for the design of the structures.

If, at any stage of the work, the forms show signs of bulging or sagging, that portion of the concrete causing such condition shall be immediately removed, if necessary, and the forms shall be reset and securely braced against further movement.

Lumber for forms shall be properly seasoned and of good quality. It shall be free from loose or unsound knots, knot holes, twists, shakes, decay, and other imperfections which would affect its strength or impair the finished surface of the concrete. The lumber used for facing or sheathing shall be finished on at least one side and two edges and shall be sized to uniform thickness.

The use of nominal 2 inch lumber, as a minimum thickness, will be required for forms for the bottoms of all superstructure girders except that in case of special forming of girders, as for curved-bottom girders where facing boards are transverse to beam, the Engineer may permit the use of 1 inch lumber. Nominal 1 inch thickness lumber will be permitted for general use on other portions of the structure if backed by a sufficient number of studs and wales.

Timber forms for exposed concrete surfaces which are required to be surface finished in accordance with these Standard Specifications shall be face lined with an approved type of form lining material such as masonite or plywood. If desired by the Contractor, facing for such surfaces may be constructed of 3/4 inch thick plywood backed by adequate studs and wales, and in this case form lining will not be required.

Forms or form lumber to be re-used shall be maintained clean and in good condition as to accuracy, shape, strength, rigidity, tightness, and smoothness of surface. Any lumber which is split, warped, bulged, marred, or has defects that may produced work inferior to that resulting from using new material, shall not be re-used.

Studs shall not be less than 2 inches by 4 inches nominal section and shall be spaced center to center not more than 20 times the actual thickness of the facing lumber. Wherever practicable, studs shall be capped at the top with a plate of not less than 2 inches by 6 inches nominal size, carefully selected as to straightness. All joints in plates shall be scabbed at least 4 feet each way to provide continuity.

Wales shall be spaced at such intervals as to hold forms securely to the designated lines. All wales shall be scabbed at least 4 feet on each side of joints to provide continuity. A row of wales shall be placed within 6 inches of the bottom of each placement.

Forms shall be rigidly braced to prevent movement while placing the concrete.

All face form material shall be fastened to all studs and shall have true horizontal and vertical joints. Facing material on horizontal and other surfaces shall be placed with parallel and square joints.

Molding specified for chamfer strips or other uses shall be made of redwood, cypress or pine materials of such grade that will not split when nailed and which can be maintained to a true line without warping. The molding shall be mill cut and dressed on all faces. Unless otherwise provided, forms shall be filleted at all sharp corners and edges with triangular chamfer strips. The strips shall be 3/4 inch measured on the sides.

Forms for railings shall be constructed to standards equivalent to first class mill work. All moldings, panel work, and bevel strips shall be straight and true with neatly mitered joints and of such design that the finished work shall be true, sharp and clean cut.

All forms shall be so constructed as to permit removal without damage to the concrete. Particular and special care must be exercised in framing forms for copings, offsets, and railing so that there will be no damage to or marring of the concrete when the forms are removed. If desired by the Contractor, the forms may be given a slight draft to permit ease of removal.

Metal form ties of an approved type shall be used to hold forms in place. Such ties shall be of a type especially designed for use in connection with concrete work, and they shall have provision to permit ease of removal of the metal as hereinafter specified. The use of wire form ties will not be permitted except for minor or special form areas where the use of rigid type metal ties would be impracticable.

All metal appliances used inside of forms to hold them in correct alignment shall be removed to a depth of at least 1/2 inch from the surface of the concrete and shall be so constructed that the metal may be removed without undue injury to the surface by chipping or spalling. Such devices, when removed, shall leave a smooth opening in the concrete surface. Burning off of rods, bolts, or ties will not be permitted.

Metal ties shall be held in place by devices attached to wales. Each device shall be capable of developing the strength of the tie.

Pipe spreaders will not be permitted.

Metal and wooden spreaders which are separate from the forms shall be entirely removed as the concrete is being placed.

Where wire ties are used, all wires, upon removal of the forms, shall be cut back at least 1/2 inch from the face of the concrete with a sharp chisel or nippers.

All cavities produced by the removal of metal ties shall be carefully cleaned and completely filled with re-tempered sand cement mortar mixed in proportion of one to three, and the concrete shall be left smooth and even.

Whenever practicable, forms shall be erected complete before the reinforcement is placed.

For narrow walls and other locations where access to the bottom of the forms is not readily attainable otherwise, adequate clean-out openings shall be provided.

At the time of placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust, and other extraneous matter.

The facing of all forms shall be treated with oil before concrete is placed. In hot weather, both sides of face forms may be required to be treated with oil to prevent warping and to secure tight joints. The oil must be applied before the reinforcement is placed. The oil used for this purpose shall be a light clear oil which will not discolor or otherwise injuriously affect the concrete surface.

In general, all forms shall be thoroughly wetted before the concrete is placed therein.

The foregoing specifications for forms, regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, re-use, oiling and wetting shall apply with equal force to all forms, except that metal forms will not require lining unless noted on the plans.

The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or line up properly shall not be used. Special care shall be exercised to keep metal free from rust, grease, or other foreign material such as will tend to discolor the concrete.

420.11 Placing Reinforcement. Reinforcement in concrete structures shall be carefully and accurately placed and rigidly supported as provided in the Item 440 "Reinforcing Steel".

420.12 Placing Concrete, General. The Contractor shall give the Engineer sufficient advance notice before starting to place concrete in any unit of the structure to permit the inspection of forms, the reinforcing steel placement, and preparations for casting. Unless authorized by the Engineer, no concrete shall be placed in any structure until prior to the completion of the formwork and the placement of the reinforcement. No concrete shall be placed before the completion of all adjacent pile driving or other operations which might prove detrimental to the concrete.

Whenever it is necessary to continue the mixing, placing, and finishing of concrete after the daylight hours, the site of the work shall be brilliantly lighted so that all operations are plainly visible. In general, however, concrete placing shall be so regulated as to permit finishing operations to be completed in the daylight hours.

The Engineer reserves the right to order postponement of the placing operations when, in his/her opinion, impending weather conditions may result in rainfall or low temperatures which will impair the quality of the finished work. In case rainfall should occur after placing operations are started, the Contractor shall provide ample covering to protect the work. In case of drop in temperature, the provisions set forth in the Section 420.13 "Placing Concrete in Cold Weather" shall be applied.

The sequence of placing concrete shall be as provided on the plans or in the specifications. The operation of depositing and compacting the concrete shall be conducted so as to form a compact, dense, impervious mass of uniform texture which shall show smooth faces on all surfaces. The placing shall be so regulated that the pressures caused by the plastic concrete shall not exceed the loads used in the design of forms.

The method and manner of placing shall be such as to avoid the possibility of segregation or separation of the aggregate or the displacement of the reinforcement. Concrete shall not have a free fall of more than 3 feet except in the case of thin walls such as culvert walls.

Spattering on forms or reinforcement bars shall be prevented if the concrete so spattered will dry or harden before being incorporated in the mass. Any hardened concrete splatter ahead of the plastic concrete shall be removed.

Each part of the forms shall be filled by depositing concrete directly as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point in the forms and running or working it along the forms will not be allowed.

After the concrete has taken initial set, the forms shall not be jarred or any strain placed on projecting reinforcement.

Chutes, troughs, conveyors or pipes used as aids in placing concrete shall be arranged and used so that the ingredients of the concrete will not be separated. When steep slopes are necessary, the chutes shall be equipped with baffle boards or be made in short lengths that reverse the direction of movement. Open troughs and chutes shall extend, if necessary, down inside the forms or through holes left in the forms, or the ends of such chutes shall terminate in vertical downspouts. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by a thorough flushing with water before and after each placement. Water used for flushing shall be discharged clear of the concrete in place. The use of chutes in excess of 35 feet total length for conveying concrete will not be permitted except by specific authorization from the Engineer.

Where the Contractor's operations involve the placing of concrete from above, that is, directly into an excavated area or through the completed forms, particularly in the case of abutments, piers, columns, retaining walls, and deep girders, and excepting thin walls such as culvert walls less than 12 inches, all concrete so placed shall be deposited through a vertical sheet metal or other approved pipe not less than 6 inches nor more than 10 inches in diameter. The pipe shall be made in sections so that the outlet may be adjusted to proper heights during placing operations.

Concrete shall be placed in continuous horizontal layers approximately 12 inches in thickness. Not more than one hour shall elapse between the placing of successive layers of concrete in any portion of the structure included in a continuous placement. The Contractor shall avoid unauthorized construction joints by placing required portions of abutments, pier walls or superstructures in one continuous operation. Laitance or foreign matter of any kind shall not be permitted to accumulate inside the forms. Openings in forms necessary for removal of shall be provided.

All concrete shall be well compacted and the mortar flushed to the surface of the forms by continuous working with concrete spading implements or mechanical vibrators of an approved type. Vibrators of the type which operate by attachment to forms or reinforcement will not be permitted. The vibrators shall be applied to the concrete immediately after deposit and shall be moved throughout the mass, thoroughly working the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms until it has been reduced to a plastic mass. The mechanical vibrator shall not be operated so that it will penetrate or disturb layers placed previously which have become partially set or hardened. The vibration shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures but shall not be done to an extent that will cause segregation. Vibration shall be supplemented by hand spading if necessary to insure the flushing of mortar to the surface of all forms.

Holes for anchor bolts in piers, abutments, bents, or pedestals may be drilled or may be formed by the insertion of oiled wooden plugs or metal sleeves in the plastic concrete. The plugs or sleeves shall be withdrawn after the concrete has set. When the holes are formed, they shall be of such diameter to permit horizontal adjustment of the bolts. The bolts shall be carefully set in mortar. In lieu of the above methods of placing, anchor bolts may be set to exact locations in the concrete when it is placed.

The placing of concrete for floor slabs of I-beam spans, girder spans, or truss spans preferably shall be done from a mixing plant located off the structure. If the mixer plant is to be located on the structure, it shall not be placed on a section of the roadway slab which has not aged for at least 10 curing days. Carting or wheeling concrete batches on a completed concrete floor slab will not be permitted until the slab has aged at least 4 curing days. If carts are used, the carts shall be wheeled on timber planking so that the loads and impact will be distributed over the slab. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

Stockpiling of concrete aggregate or cement on bridge floors will be permitted only when authorized by the Engineer, and, when permitted, the stock piles shall be uniformly distributed and shall be limited to not over 2 feet maximum depth. The storing of reinforcing or structural steel on completed roadway slabs shall generally be avoided, and, when permitted, such storage shall be limited to quantities and distribution that will not induce excessive stresses.

- 420.13 Placing Concrete In Cold Weather. No concrete shall be placed when the atmospheric temperature is at or below 40°F (taken in the shade away from artificial heat) unless permission to do so is given in writing by the Engineer. When such permission is given or in cases where the temperature drops below 40°F after the concreting operations have been started, the Contractor shall furnish sufficient canvas and framework or other type of housing to enclose and protect the structure in such way that the air around the forms and fresh concrete can be kept at a temperature not less than 50°F for a period of five days after the concrete is placed. Sufficient heating apparatus such as stoves, or steam equipment and fuel to furnish all required heat shall be supplied. The treatment of mixing water and aggregates used in mixing concrete shall be as specified in "Concrete". The placing of concrete in cold weather shall conform to the requirements of ACI306.

It is understood that the Contractor is responsible for the protection of concrete placed under any and all weather conditions. Permission given by the Engineer to place concrete during freezing weather will in no way relieve the Contractor of the responsibility for satisfactory results. Should concrete placed under such conditions prove unsatisfactory, it shall be removed and replaced at the expense of the Contractor.

- 420.14 Placing Concrete in Hot Weather. Unless otherwise directed by the Engineer, when the temperature of the air is above 85°F, an approved

retarding agent will be required in all concrete or direct traffic culverts. An approved retarding agent will be required in all cased drilled shafts, regardless of temperature.

- 420.15 Placing Concrete In Water. Concrete shall be deposited in water only when specified on the plans or with the permission of the Engineer. The forms, cofferdams, or caissons shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping will not be permitted while the concrete is being placed, nor until it has set for at least 36 hours.

The concrete shall be carefully placed in a compact mass by means of a tremie, closed bottom-dump bucket or other approved method that does not permit the concrete to fall through the water. The concrete shall not be disturbed after being deposited. Depositing shall be regulated to maintain an approximately horizontal surface at all times.

When a tremie is used, it shall consist of a tube having a diameter of not more than 10 inches, constructed in sections having watertight connections. The means of supporting the tremie shall permit the movement of the discharge end over the entire top surface of the work and shall permit the tremie to be rapidly lowered when necessary to choke off or retard the flow. The number of times it is necessary to shift the location of the tremie, for any continuous placement of concrete, shall be held to a minimum.

During the placing of concrete, the tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the level of the bottom of the hopper. The flow shall then be stopped by lowering the tremie. The placing operations shall be continuous until the work is complete.

When concrete is placed by means of a bottom-dump bucket, the bucket shall have a capacity of not less than 1/2 cubic yard. The bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. It shall then be raised, very slowly, during the upward travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

- 420.16 Placing Concrete in Slab Spans. Concrete in slab spans shall be placed in longitudinal strips. Placing preferably shall be started at a point in the center of the span adjacent to one curb and the longitudinal strip thus started shall be completed by depositing concrete uniformly in both directions toward the ends of the span. The width of longitudinal strips shall be such that the concrete in any strip will not take its initial set before the adjacent strip is placed. The concrete in the curbs shall be placed in proper sequence to be monolithic with the adjacent longitudinal strip of the slab.

The forms for the bottom surface of the slab shall be maintained true to the required vertical alignment during the placing of concrete in the span. For convenience in checking the vertical alignment, an approved system of "tell-tales" shall be installed and maintained by the Contractor. The "tell-tales" shall be attached to the form and shall provide a convenient means of matchmarking with reference to points set on stakes or other suitable reference points set independent of the forms and falsework for the span being placed.

On completion of the filling of the curb forms, the curbs shall be brought to the correct camber and alignment, and then they shall be struck off and float finished.

As soon as concrete is placed in a longitudinal section of the slab of a width necessary to permit finishing operations, the slab shall be finished in accordance with the requirements of "Finish of Roadway Slabs".

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Placing Concrete in Deck Girders Spans. Unless otherwise provided, the girders, slab and curbs of deck girder spans shall be placed in one continuous operation. Concrete shall be placed in longitudinal sections. Placing preferably shall commence with a section adjacent to one curb, and successive sections continuing across the roadway shall follow. The width of each longitudinal section shall be governed by the size of the mixing apparatus and shall be such that each successive section shall be placed before the adjacent completed section shall have attained its initial set. The placing of concrete in curbs shall be in the proper sequence to be monolithic with the adjacent slab or girder section. Except for spans on a grade of 1-1/2 percent or more, concreting in each longitudinal section preferably shall be started at the middle of the span and shall be continued in both directions to the ends of the span. For spans on a grade of 1-1/2 percent or more, concreting shall be commenced at the low end of the span. The filling of the girder stems ahead of placing the concrete in the slab will be permitted provided the slab is placed not later than one hour after the filling of the girder stem.

During the operations of placing concrete in the span, the bottoms of the girders and overhanging slabs shall be maintained true to required vertical alignment. For convenience in checking the vertical alignment, the Contractor shall attach to the form of each girder an approved system of "tell-tales" which shall provide a means of matchmarking for reference to established grades fixed on stakes or other suitable reference points set independent of the forms and falsework for the span being placed. Care shall be exercised to assure that the "tell-tales" system is not altered or destroyed after the matchmarking is done.

On completion of the filling of the curb forms, the curbs shall be brought to the correct camber and alignment, and then shall be struck off and float finished.

The surface of the floor slab shall be finished as provided in Section, "Finish of Roadway Slabs". The finishing shall be done as soon as

possible after the placing of concrete is completed in a section of slab of sufficient width to permit finishing operations.

- 420.18 Placing Concrete In Floors on Steel Spans. Before concrete floor slabs are placed on steel truss spans, the falsework under the span shall be released and the span swung free on its supports. The floor slab shall be placed symmetrically about the centerline of the span beginning at the center and working simultaneously toward each end, or beginning at the ends and working simultaneously toward the center. Where construction joints are provided at each panel point of the truss, variations from the above sequence will be permitted to the extent of one unsymmetrical panel; that is, concreting will be permitted in a panel on one side of the centerline of span provided that the corresponding panel on the opposite side of the centerline shall be the next panel placed.

Placing of the slab in each panel and the placing of the slab on steel I-beam spans shall be in accordance with the provisions of Section "Placing Concrete in Slab Spans".

Concrete placed around steel shapes shall be deposited on one side of the shape and shall be spaded or vibrated until it flushed up over the bottom flange on the opposite side of the member, after which, it may be placed on both sides to completion.

On completion of the filling of the curb forms, the curbs shall be brought to the correct camber and alignment, and they shall then be struck off and float finished as described in Section 420.21 "Treatment and Finishing of Horizontal Surfaces Except Roadway Slabs".

The surface of the floor slab shall be finished as provided in Section 420.22 "Finish of Roadway Slabs". The finishing shall be done as soon as possible after the placing of concrete is completed in a section of slab of sufficient width to permit finishing operations.

- 420.19 Placing Concrete in Box Culverts. In general, the base slab, curtain walls, lower haunches, and the bottom portion of the sidewalls up to a height approximately one inch above the haunches, or sidewalls to a height approximately 4 inches above the base slab when no haunch is provided, shall be placed as a monolith. The top surface of the base slab and the top surface of the top slabs which do not carry direct traffic shall be accurately finished by hand floating methods before the concrete has attained its initial set. Before concrete is placed in the sidewalls, the footing area joining the walls shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material.

In the construction of box culverts less than 4 feet in clear height, the sidewalls and top slab generally shall be placed monolithic. When box culverts are greater than 4 feet in clear height, a construction joint may, if shown on the plans, be provided between the sidewalls and the top slab. In case no joint is provided, an interval of not less than 1 hour or more than 2 hours shall elapse between the placing of concrete in the walls,

and concrete in the haunches and top slab, such interval to allow for shrinkage in the wall concrete. Curbs and haunches at tops of walls shall be placed monolithic with the top slab.

The tops of culvert slabs which are intended to carry direct traffic shall be finished and surface tested in accordance with the provisions for finishing roadway slabs.

420.20 Placing Concrete in Foundations of Structures. Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the Engineer and permission has been given to proceed.

The placing of concrete bases above seal courses will be permitted after the caissons or cofferdams are free from water and the seal course cleaned. Any necessary pumping or bailing during the concreting operations shall be done from a suitable sump located outside the forms.

All temporary wales or braces on the inside of cofferdams or caissons shall be constructed or adjusted as the work proceeds, so that construction joints in bases or shaft, in addition to those shown on the plans, will not be necessary.

Concrete in deep foundations shall be placed in a manner that will avoid separation of the aggregates or displacement of the reinforcement. Suitable chutes or vertical pipes shall be provided.

When footings can be placed in dry foundation pits without the use of cofferdams or caissons, forms may be omitted, if desired by the Contractor and approved by the Engineer, and the entire excavation filled with concrete to the elevation of the top of footing. Where this procedure is followed, no measurement for payment will be made for concrete placed outside of the footing dimensions shown on the plans.

Concrete in columns shall be placed monolithically unless otherwise provided. Unless a construction joint is provided at the top of columns, an interval of not less than 1 hour or more than 2 hours shall elapse between the placing of concrete in columns and the placing of concrete above the top of columns. Such interval is intended to allow for shrinkage of the column concrete.

420.21 Treatment and Finishing of Horizontal Surfaces, Except Roadway Slabs. All upper surfaces not covered by forms, such as tops of railing posts, railings, caps, curbs, parapets, copings, bridge seats, and sidewalk areas shall be completed by placing excess material in the forms and removing or striking off such excess with a wooden template forcing the coarse aggregate below the mortar surface. The use of mortar topping for surfaces under this classification will not be permitted.

After the concrete has been struck off as described above, the surface shall be thoroughly worked and floated with a wooden, canvas, or cork

float. After floating and before the finish has set, all surfaces, except sidewalks so finished, shall be lightly striped with a fine brush, to remove the surface cement film, leaving a fine grained, smooth but sanded texture. That portion of curbs or parapets which is to be the seat for concrete rail posts or webs of concrete railings shall be roughened in an approved manner.

420.22 Finish of Roadway Slabs. As soon as concrete placing operations have been completed for a longitudinal roadway slab section of sufficient width to permit finishing operations, the concrete shall be approximately leveled and then struck off, screeded and tamped by a longitudinal screed. The screed shall be of a design adaptable for the purpose intended. It shall have provisions for adjustment to the desired camber and be sufficiently rigid to hold true to shape during use.

The first strike-off operation shall leave the concrete surface at an elevation above grade so that, when consolidation and finishing operations are completed, the slab will be at the exact grade elevation shown on the plans with proper allowance for finished camber as hereinafter provided. The tamping and screeding operations shall be continued until the concrete is properly consolidated and surface voids eliminated. The surface shall then be brought to a smooth true alignment by means of longitudinal screeding, floating, belting, and/or other methods approved by the Engineer. Spans over 40 feet in length may be screeded in two or more sections if suitable intermediate templates are installed. Unless otherwise provided, the templates shall be of such design as to permit early removal in order to avoid construction joints and to permit satisfactory finishing at and adjacent to the site of the template.

After the finishing operations are completed and while the concrete is still plastic, the surface shall be straightedged by the Contractor, using a standard 10 foot metal straightedge. Any deviations from the face of the straightedge greater than those prescribed under the following surface test shall be corrected before the concrete has attained its initial set. The final belting of the slab shall be done after this straightedging is completed.

After the concrete has attained its final set, the roadway surface shall be tested again with a standard 10 foot metal straightedge for irregularities, and the surface shall be corrected, if necessary, to conform to the following:

The straightedge shall be placed parallel to the centerline of the road so as to bridge any depression and touch high spots. Ordinates measured from the face of the straightedge to the surface of the slab shall not exceed 1/16 inch per foot from the nearest point of contact and the maximum ordinate shall not be greater than 1/8 inch. The surface shall be corrected by grinding off the high spots as may be required in order to conform to these limits.

In the case of concrete slab or girder spans, the floor shall be finished so as to provide a camber sufficient to offset the dead load deflection of the span; other spans shall be so finished if directed by the Engineer. Unless otherwise shown on the plans, the camber at the center of the span shall be made 1/8 inch for each 10 feet of span length with a maximum camber of 1/2 inch. When camber is provided, the ordinate to the straightedge may be as much as 3/16 inch at the end of the straightedge but shall not exceed 1/16 inch under its center.

420.23

Curing Concrete. Careful attention shall be given by the Contractor to the proper curing of all concrete in the structure. The Contractor, at his/her option, may elect to use other curing methods outlined in the Item 421 "Structural Concrete". If cotton mats are used, all upper surfaces not formed, except roadway and side walk slabs, shall be covered by cotton mats immediately following the floating operations and shall be kept thoroughly wet for a period of 4 curing days after the concrete is placed. All formed surfaces requiring a surface finish shall be covered with wet cotton mats immediately after the forms are removed and shall be kept covered and wet until the concrete has aged at least 4 curing days. Intermission will be permitted as needed to allow the surfaces to be finished. The mats shall be held in direct contact with the concrete. Water used for curing shall be free from injurious amounts of oil, acid, alkali, salt, or other deleterious substances.

When forms are removed from concrete caissons in less than 4 curing days and when the sinking operations do not immediately follow the form removal, the caissons shall be cured by being covered with wet cotton mats which shall remain in place until the caissons have aged at least 4 curing days.

Immediately following the finishing operations, concrete roadway and sidewalk slabs shall be covered with wet cotton mats or with a temporary covering of canvas or burlap. The temporary covering will be required in all cases where the size of span, size of mats, or other factors are such that the mats cannot be placed immediately following the finishing operation without marring the finish of the slab.

The canvas or burlap covering material shall weigh not less than 10 ounces per square yard, and the sections shall be placed with a lap at the edges of at least 8 inches. The material shall be saturated with water previous to placing and shall be kept saturated as long as it remains in place. Care shall be exercised in the placing of the cover material in order that the concrete surface shall not be disturbed.

When a temporary covering is used, it shall remain in place only until the slab has sufficiently hardened that a cotton mat covering can be substituted without disturbing or marring the finish of the slab. Cotton mats shall be thoroughly saturated before placing and shall be maintained in a saturated condition for a period of at least 8 curing days after the concrete is placed.

Ponding, instead of cotton mat covering may be used for curing roadway, sidewalk slabs, and top slabs of culverts. In addition, membrane curing as specified in the Item 526 "Membrane Curing", may also be used, where appropriate.

420.24 Removal of Forms and Falsework. Except as hereinafter provided, forms for surfaces required to be finished shall be removed when the concrete has aged not less than 1/2 nor more than 2 curing days after the concrete is placed. In order to facilitate slab finishing, forms for inside curb faces on roadway slabs may be removed in not less than 3 hours if the concrete has set sufficiently to permit form removal without damage to the curbs.

Forms and falsework for the portions of structures which do not require surface finish may be removed when the concrete has aged for the minimum number of curing days set forth in the following table:

Forms and falsework under slabs or girders having span lengths of 10 feet and less.....7 Days

Forms and falsework under slabs or girders having span lengths over 10 feet and less than 17 feet7 Days plus one day for each foot of span over 10 feet

Forms and falsework under slabs or girders having spans over 17 feet in length.....14 Days

Forms and falsework under caps or tie beams of framed bents.....4 Days

Forms under caps of pile bents.....4 Days

Forms & falsework under webwalls of piers.....7 Days

Forms for walls, columns & sides of beams..... 4 Days

Forms for concrete caissons.....2 Days

The term "curing day" will be interpreted as any calendar day on which the temperature is above 50°F for at least 19 hours. Colder days may be counted if satisfactory provision is made to maintain the air temperature adjacent to the concrete constantly above 50°F throughout the entire day. In continued cold weather, when artificial heat is not provided, the Engineer may permit the removal of forms and falsework at the end of a period of calendar days equal to twice the number of curing days stated in the above table. Test specimens may be made, at the option of the Engineer, for the purpose of determining a satisfactory time of form and falsework removal in cold weather. When tests made on specimens cured under like conditions to the curing of the structure indicate that strengths equivalent to the 7 day strengths as given in the Item 421 "Structural Concrete" have been attained, the forms and falsework may be removed. In no event shall this removal be done in less time than the curing periods given in the above table.

Forms for the portions of slabs that cantilever more than one foot beyond the outside beams shall not be removed in less than four curing days, nor shall falsework under girders and bent caps for framed bents be removed in less than the minimum time specified regardless of requirements for surface finish. The above provisions relative to form removal shall apply only to forms or parts of forms which are so constructed as to permit removal without disturbing forms or falsework which are required to be left in place for a longer period on other portions of the structures.

420.25 Defective Work. Any defective work discovered after the forms have been removed shall be repaired immediately. If the surface of the concrete is bulged, uneven, or shows excess honeycombing or form marks, which defects, in the opinion of the Engineer, cannot be repaired satisfactorily, the entire section shall be removed and replaced. In repairing honeycombed areas, all loose material shall be removed before the repair work is started. No extra compensation will be allowed for the extra work or materials involved in repairing or replacing defective concrete.

420.26 Finishing Exposed Surfaces. All railing, curbs, the underside of overhanging slabs, the outside and bottom of exterior girders or fascia beams, and all portions of piers, columns, bents, abutments, retaining walls and culverts, which are exposed to view after backfill and roadway embankments are placed shall be surface finished. The area inside of culvert barrels including both sidewalls and the underside of the top slab for a distance equal to 1/3 the clear height but not less than 18 inches shall be considered as exposed to view. The remaining surface inside of culvert barrels, the underside of roadway slabs between exterior girders or beams, the sides and bottoms of interior superstructure girders and bottoms of slab spans will not be required to be surface finished unless such surfaces are not true or have porous spots or honeycombed areas. In case these defects occur, the areas shall be given a first surface rubbing.

The operation of surface finishing shall be in accordance with the following provisions:

As soon as forms are removed, all necessary pointing shall be done. When the pointing has set sufficient to permit it, all surfaces requiring surface finish shall be wet with a brush and given a first surface rubbing with a No. 16 Carborundum Stone or an abrasive of equal quality. The rubbing shall be continued sufficiently to bring the surface to a paste, to remove all form marks and projections, and to produce a smooth dense surface without pits or irregularities. The use of cement to form a surface paste will not be permitted. The material which has been ground to a paste in this process shall be carefully spread or brushed uniformly over the surface and allowed to take a reset.

In general chamfered corners shall not be rubbed in the first surface rubbing.

During the process of conditioning the completed structure for final acceptance, the surfaces of the entire structure requiring finish shall be cleaned free from drip marks and discolorations and shall be given a final finish rubbing with a No. 30 Carborundum Stone or an abrasive of equal quality. On completion of this rubbing, the surface shall be neatly striped with a brush, and the mortar on the surface shall be allowed to take a reset. The surface shall then be washed down with clean water. The entire structure shall be left with a clean, neat, and uniform appearing finish and shall be uniform in color.

The surfaces of concrete roadway and sidewalk slabs shall be finished by floating, screeding, and belting as provided in Section 420.22 "Finish of Roadway Slabs".

- 420.27 Special Surface Finishes. When so specified, special surface finishes shall be employed for ornamental panels, copings, and like construction. In general, the method and manner of performing this work will be fully provided for in the plans or special provisions to these Standard Specifications.

In case of special finishes, the Contractor will be required to prepare test or sample panels showing the method and manner of finish. The choice and selection of the aggregate and other features affecting the work shall be approved by the Engineer before any further work is done.

- 420.28 Measurement and Payment. No direct compensation will be made for "Concrete Structures". Measurement and payment for quantities of concrete, railing, piling, excavation and other proposal items, which constitute the completed and accepted structure, will be made in accordance with the provisions of the pertinent specifications.

There are no line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 421 "Structural Concrete"
Item 438 "Preformed Joint Seal"
Item 440 "Reinforcing Steel"
Item 526 "Membrane Curing"

END OF ITEM 420

SECTION 02100 - SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Visit site to ascertain actual conditions and items related to the work of this section.
2. Provide necessary protection for persons, existing buildings, improvements, utilities, and property including tree protection fencing.
3. Remove and grub all vegetation, noted on the drawings.
4. Demolition and removal of above and below grade improvements as required for new work, including but not limited to existing paving walk, shell material, etc.
5. Mobilization of equipment at the site.
6. Providing requirements for personnel and facilities.
7. Securement of any temporary traffic channelizing devices required for the safe construction of this project.
8. Removing above- and below-grade site improvements.
9. Disconnecting and capping or sealing site utilities.

1.2 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

- E. Contractor shall provide access to utility owners, and others as designated, to the Work site at all times to relocate, service, and inspect their facilities. The Contractor shall cooperate with utility owners and others in facilitating such work so as not to delay the Work of this Contract.

1.4 CONTINUITY OF SERVICE

- A. Contractor shall ensure continuity of utility service and shall maintain, in a safe and satisfactory operating condition, all overhead, surface and subsurface utilities.

PART 2 - PRODUCTS - Not Applicable

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.
- D. The location of staging areas and equipment shall be subject to the approval of the Owners Representative and Owner and shall be site close to that portion of the Work for which such items will be used.
- E. The Contractor may, at his discretion, erect a temporarily fenced area for securing equipment, materials, etc. as directed by the Owners Representative. Owner will not assume any responsibility for security of any materials, equipment, etc. during construction of the project.

3.2 TEMPORARY TRAFFIC

- A. Temporary traffic channelizing devices shall be installed in accordance with the requirements of Part VI of the TxDOT manual on Uniform Traffic Control Devices for Streets and Highways.
- B. Contractor shall submit his request and plan for temporarily channelizing traffic to Owners Representative and Owner for approval as appropriate.
- C. Devices shall be maintained as necessary during the course of the Work, and shall be removed from the Site when no longer needed, or as otherwise directed by Owners Representative to Owner.

3.3 CONSTRUCTION VEHICULAR TRAFFIC

- A. Construction vehicular traffic shall be restricted to routes approved by Owners Representative and Owner.

3.4 PEDESTRIAN TRAFFIC

- A. Whenever pedestrian circulation is interrupted, flashing warning lights shall be employed to alert pedestrians.

3.5 UTILITIES

- A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.

3.6 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

3.7 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
 - 1. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

3.8 CLEANUP

- A. Cleanup all debris caused by the work of this Section, keeping the premises clean and neat at all times.

END OF SECTION 311000

SECTION 02200 - EARTHWORK

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Work Included: Excavating, filling, and grading required for this work included, but is not necessarily limited to:

1. Cutting and filling to attain indicated grade.
2. Rough grading of the site.

B. Related Work Described Elsewhere:

Site Preparation: Section 02100

1.02 JOB CONDITIONS:

A. Existing Conditions:

1. Existing Utilities: Should uncharted or incorrectly charted piping or other utilities be encountered during earthwork, consult with the Owner immediately for directions as to procedure. Cooperate with the Owner, and utility companies in keeping services and facilities in operation. Repair damaged utilities to the satisfaction of the utility owner.

B. Protection:

1. Protection of Persons and Property: Protect vegetation, utilities, pavements and other facilities immediately adjacent to earthwork, from damage.
2. Protect all objects designated to remain.

C. Environmental Conditions:

1. Use all means necessary to control dust on and near the work and on and near all off-site borrow areas if such dust is caused by the Contractor's operations during performance of the work or if resulting from the condition in which the Contractor leaves the site.
2. Thoroughly moisten all surfaces as required to prevent dust from being a nuisance to the public, neighbors and concurrent performance of other work on the site.

PART 2 - PRODUCTS

2.01 FILL MATERIAL:

A. General:

1. Fill Materials: Provide satisfactory soil materials for fill, free of clay, rock or gravel larger than 2" in any dimension, debris, waste, frozen materials, vegetable matter, and other deleterious matter. Use excavated or borrow material that has been sampled, tested and approved as satisfactory material.

B. Select Fill: On site materials are generally acceptable for use.

- C. Dirt Fill: Fill dirt approved by the Owner shall be furnished, hauled and spread on the site by this Contractor at all locations where required to bring grades, into accordance with the drawings.

D. Select Fill Material (at paving, foundation and courts):

1. Liquid Limit: 20 to 40
2. Plasticity Index: 8 to 20
3. Linear Shrinkage: 10% maximum
4. Purity: No stone or debris larger than 3", no organics.

E. Ordinary Fill Material:

1. Free of high organic topsoil (usually in top 6" to 8" of grass or weed growth).
2. From normally dry, well drained location
3. Free of trash, stone and debris that could interfere with compaction or promote settlement.
4. Of suitable moisture for compaction.

F. Sand Leveling Layer:

1. Location: Under courts. Elsewhere if directed.
2. Material: Bank sand or comparable.
3. Thickness: Sufficient for proper leveling, or to a minimum shown on Drawings.

PART 3 - EXECUTION:

3.01 GENERAL:

Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions 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.

3.02 EXCAVATION:

- A. Cut surface to comply with cross-sections, elevations and grades as shown.
- B. When excavation has reached subgrade elevations, notify Owner, or his representative, who will make an inspection of conditions.
 - 1. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material as directed by Owner or his representative.
 - 2. Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in work.
- C. Slope sides of excavations to comply with applicable codes and ordinances. Shore and brace where sloping is not possible either because of space restrictions or stability of material being excavated. Provide and maintain materials for shoring and bracing, in good serviceable condition. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.
- D. Protect soils exposed at the base of completed foundation excavations against disturbance from construction activities and changes in moisture content. Where foundations cannot be poured the same day an excavation is completed, clear footing subgrade of all loose and unsatisfactory material, compact at optimum moisture content as specified herein, and protect with a minimum 3" thick seal slab of lean concrete. Contractor may, where bottom of foundation will be exposed to movement of crawler type heavy equipment, leave about 1' of undisturbed soil above indicated bottom of footing elevations until just prior to final excavation.
- E. Prevent surface water from flowing into excavations and from flooding Project Site and surrounding area. Do not allow water to accumulate in excavations. Provide and maintain dewatering system components necessary to convey water away from excavations. For lake related construction provide dams as required to maintain dry excavations.
- F. Conform to elevations and dimensions shown within a tolerance of "0.10' and extending a sufficient distance from footings and foundations to permit installation of services, other construction required, and for inspection.
- G. Dig trenches to the width and depths required for the particular items to be installed, and sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe or conduit.
 - 1. For pipes or conduit 5" or less in nominal size and for flatbottomed multiple duct conduit units, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
 - 2. For pipes of conduit 6" or larger in nominal size, tanks and other mechanical/electrical work indicated to receive base material, excavate to base depth indicated, or, if not otherwise indicated, to 6" below bottom of work to be

- supported.
3. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
 4. Backfill trenches with concrete as specified in Section 03300 where trench excavations pass within 18" of column or wall footings and which are carried below bottom of such footings, or which pass under wall footings. Place concrete to level of bottom of adjacent footing.
 5. Do not backfill trenches until tests and inspections have been made and backfilling authorized by Owner. Use care in backfilling to avoid damage or displacement or pipe systems.
- H. Excavate unsatisfactory soil materials encountered that extend below required elevations, to additional depth directed by the Owner's representative. Such additional excavation, provided it is not due to fault or neglect of Contractor, will be measured as directed by Owner and paid for as a change in the Work.

3.03 FILL OPERATIONS:

- A. Before placing fill material, remove all debris subject to termite attack, rot, or corrosion, and all other deleterious materials from areas to be filled. Deposit fill in layers not more than 8 inches thick. All fill materials shall be free from roots, plaster, batts and unsuitable materials. Place depth as specified, for the full width of the cross section. The finished subgrade shall be brought to elevations indicated.
- B. Before compaction, moisten or aerate each layer as necessary to provide the optimum moisture content of the soils material. Compact each layer to the required percentage of maximum density for each area classification. Do not place fill material on surfaces that are muddy.

3.04 SOIL DENSITY:

- A. "Percentage of Maximum Density" Requirements:

Unless otherwise indicated on the plans, provide not less than the following percentages of the maximum density of the soil materials, compacted at optimum moisture content for each layer of soil material-in-place. Density shall be determined by the Standard Proctor Method. Structures, slabs, courts, and pavements: 95% of maximum density. All other construction effected areas: 90% of maximum density.

3.05 COMPACTION:

- A. General:
 1. Perform the compaction of soil materials using suitable soil compaction equipment for the materials to be compacted and the work area locations.
 2. Control soil compaction during construction for compliance with the percentage

of maximum density specified for each area classification.

B. Compaction Equipment:

Use sheepsfoot rollers, pneumatic tired rollers, tamper rollers, vibrating tampers, or other compaction equipment capable of obtaining the required density throughout the entire layer being compacted.

C. Moisture Control:

1. Where the subgrade or layer of soil materials must be moisture conditioned before compaction, uniformly apply the required amount of water to the surface of subgrade, or layer of soil material, in such manner as to prevent free water appearing on the surface during or subsequent to compaction operation. Acceptable moisture content will be plus or minus 2% from optimum as determined by ASTM D-698.
2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified percentage of maximum density.

D. Moisture Control Equipment:

Provide equipment capable of adding measured amounts of moisture to the soil material as determined by moisture-density relation tests.

3.06 GRADING:

Uniformly grade all areas within the limits of site grading under this section, including adjacent transition areas. Smooth the finished surface (lightly compacted) with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

Fill low areas resulting from removal of unsatisfactory soil materials, obstructions, and other deleterious materials, using satisfactory soil material. Shape to line, grade and cross section as shown on the drawings, and assuring proper draining away.

Grading Around Walks:

- A. The grade of walks shall not restrict the flow of the natural drainage system present in the area around the walks. Specifically, the cross section of the walk shall be graded so that drainage flow at the high side will flow into and across the walk so that no ponding will occur on or near the walk. All natural swales or valleys shall be maintained by creating box culverts, or with pedestrian bridges at these locations along the walk.

B. Special Note:

All concrete walks shall be laid out and constructed in such a manner as to provide positive drainage away from, and/or around the finished walks. No finished concrete walks will be approved which either permit ponding of water on the

walks' surface or impede the natural drainage or water around them. Related earthwork on either side of all concrete walkways will be required to whatever limits or distances are necessary to achieve these drainage requirements.

3.07 MAINTENANCE:

A. Protection of Graded Areas:

Protect newly graded areas from traffic and erosion, and keep free of trash and debris.

B. Reconditioning Compacted Areas:

Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape and compact to the required density prior to further construction. Use hand tamping for recompaction over underground utilities, if any.

3.08 CLEANING AND DISPOSAL:

Disposal of Excess and Waste Materials: Remove all excess excavated material, trash, debris and waste materials, from the Owner's property and legally dispose of it.

3.09 TESTING:

The Contractor shall employ a testing laboratory acceptable to the Owner to perform the field and lab tests of the fill materials and operations. The testing laboratory shall perform tests as directed by the Owner, the frequency of which will be established a minimum of one week prior to the beginning of fill placement. The Contractor will be responsible for notifying the testing laboratory of the progress of the work in adequate time to allow scheduling of personnel. The testing will be performed at the surface of existing grades or cut areas as well, and this should not be overlooked in notifying the laboratory.

The testing laboratory will be responsible for verbally informing the Contractor of the test results immediately upon completion, so unnecessary delay is eliminated and unsatisfactory work is not covered up. Continued progress of the work shall not relieve the Contractor of the responsibility of complying with specification requirements. The testing laboratory shall notify the Contractor and the Owner in writing of the test results on the same day the tests are completed.

3.10 INSPECTION AND ACCEPTANCE:

- A. Inspection of work covered by this contract shall be made by the Owner upon written notice requesting such inspection by the Contractor at least ten (10) days prior to the requested date. After inspection, the Contractor shall be notified regarding the acceptance of this work. If any part of the work is not found to be in conformance with the plans and specifications, the Contractor shall make the necessary adjustments and request a new inspection.

END OF SECTION 02200

SECTION 07920 - JOINT SEALERS

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. Provide sealants at intersection of building components.

1.3 SUBMITTALS

- A. Submit for approval samples, product data.

1.4 QUALITY ASSURANCE

- A. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Joints designed for expansion and movement conditions at site:
 - 1. Exterior joints on vertical surfaces: Non-sag polyurethane; Pecora Dynatrol II or Tremco Dymeric or approved equal.
 - 2. Primers, bond breakers, and backer rods compatible with sealant and adjacent surfaces.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine substrate; report unsatisfactory conditions in writing. Beginning work means acceptance of substrates.
- B. Provide sealants in colors as selected from manufacturer's standards.
- C. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction and with

uniform appearance. Coordinate with work of other sections. Clean and prime joints, and install bond breakers, backer rods and sealant as recommended by manufacturers.

- D. Depth shall equal width up to 1/2" wide; depth shall equal 1/2 width for joints over 1/2" wide.
- E. Cure and protect sealants as directed by manufacturers. Replace or restore damaged sealants. Clean adjacent surfaces to remove spillage.

END OF SECTION 07920

SECTION 129300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Seating.
2. Tables.
3. Bicycle racks.
4. Trash receptacles.
5. Play equipment.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For each exposed finish.
- C. Material Certificates: For site furnishings, signed by manufacturers.
- D. Maintenance Data.
- E. Sample of drainage gravel.
- F. Sample of fall surface material.
- G. Manufacturers layout of play equipment, including fall zones and playground edge layout and location.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Refer to equipment list on drawings for all site furnishings, materials, finishes, colors, etc.
- B. PVC Sewer Pipe and Fittings, NPS 15 (DN 375) and Smaller: ASTM D 3034 SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.
- C. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Sleeves – ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine subgrades, finished surfaces and installation conditions. Do not start site furnishings work until unsatisfactory conditions are corrected.

3.2 LOCATION AND INSTALLATION

- A. All locations shall be staked by Contractor and approved by Owner's representative prior to commencement of work. Location shall be as indicated on drawings.
- B. Install landscape furnishings as per manufacturer's instructions. The manufacturer's instructions shall be considered a part of these Specifications. Installation contractor shall be a contractor approved by manufacturer for installation of manufacturer's equipment.
- C. All areas surrounding locations of landscape accessories shall be minimally disturbed. Contractor shall re-grade and repair areas and return site and improvements to original condition.
- D. Contractor to confirm all fall zone requirements prior to installing equipment. Immediately notify the Owner's Representative of any discrepancies.

3.3 INSTALLATION

- A. Site Furniture
 - 1. Assemble sections per manufacturer's recommendations.
 - 2. Install level and plumb. Shim as required to obtain an unyielding surface.
 - 3. Touch up all abraded, welded and scratched surfaces with matching rust inhibitive paint supplied by manufacturer.

PART 4 – COMPLETION

4.1 CLEAN-UP

- A. The Contractor shall clean the site daily from trash and debris resulting from construction operations at no additional cost to Owner. All walks, roads and circulation routes shall be kept clean and free from debris, material and equipment.
- B. Upon completion of the work covered by this section, the Contractor shall clean up all areas by removing spoil piles, surplus material and equipment from the site. The ground surface shall be restored to its original condition.

END OF SECTION 129300

SECTION 321445 - DECOMPOSED GRANITE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of contract, including General and Supplementary Conditions and all applicable specification sections, apply to this section.

1.2 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

- A. Provide labor, materials, equipment and appliances necessary to install and complete decomposed granite pathway in accordance with Contract Documents.
- B. Work shall include, but not necessarily be limited to, compaction of subgrade, installation of edge treatment, and installation of decomposed granite.

1.3 RELATED WORK OF OTHER SECTIONS

- A. Coordinate work of this Section with work of other Sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other Sections.

1.4 QUALITY ASSURANCE

- A. The Contractor is responsible for correction of work which does not conform to the specified requirements, including strength, tolerances and colors. Correct deficient materials as directed by the Owner.
- B. Installer: a firm with a minimum of (3) three years experience in the successful installation of similar work in similar quantities. Firm must provide Owner a list of jobs completed which can be inspected by Owner or Owner's Representative. A minimum of 2 of these completed jobs must be located in the area similar to this job.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's product data with application and installation instructions for all materials and items.
- B. Samples: Decomposed granite of size and color specified.

1.6 WARRANTY

- A. Warrant the work specified herein for 2 years against becoming unserviceable or causing an objectionable appearance resulting from either defective or non-conforming materials and workmanship.
- B. Defects shall include but shall not be limited to settling.

1.7 PRODUCT HANDLING

- A. Material shall be delivered and stockpiled at job site at a location agreed upon with the Landscape Architect and Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Decomposed Granite: The decomposed granite shall be pink in color.
- B. Edge Treatment: As per drawings.
- C. Weed Barrier: Woven soil separator/weed barrier to be installed on the path system shall be Pro 5 Weed Barrier as available through San Jacinto Environmental Supply, 2221 A West 34th Street, Houston, TX 77018, 713-957-0909.

PART 3 – EXECUTION

3.1 DELIVERY AND STORAGE

- A. Promptly notify the Owner in advance of the time of delivery of the decomposed granite material.

3.2 PREPARATION

- A. Review related drawings and stake out on the ground areas to receive decomposed granite and obtain approval of the Owner before excavation work is begun.
- B. In order to minimize conflict, locate all existing utilities prior to beginning work.

3.3 INSTALLATION

- A. Base:
 - 1. Excavate for granite material where designated on the drawing only.
 - 2. Compact subgrade to 95% maximum density.
- B. Decomposed Granite:
 - 1. Decomposed granite shall be clean and free of foreign materials before installation.
 - 2. Installation should start from one end and proceed forward over the undisturbed laying course.
 - 3. Work shall be level and true to line and grade; shall be installed properly to coincide and align with adjacent work and elevations. All edges must be retained as per Detail.
 - 4. All decomposed granite shall be rolled and compacted to a 4" depth. Minimum cross slope shall be 1½ %.

END OF SECTION 321445

SECTION 328400 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes piping, valves, sprinklers, accessories, controls, and wiring for **automatic**-control irrigation system.

1.2 DEFINITIONS

- A. Irrigation Lateral Lines: Downstream from control valves to sprinklers, specialties, and drain valves. Piping is under pressure during flow.
- B. Drain Piping: Downstream from circuit-piping drain valves. Piping is not under pressure.
- C. Irrigation Main Piping: Downstream from point of connection to water distribution piping to, and including, control valves. Piping is under water-distribution-system pressure.

1.3 SUBMITTALS

- A. Product Data: Include pressure ratings, rated capacities, and settings of selected models for the following:
 - 1. General-duty valves.
 - 2. Specialty valves.
 - 3. Control-valve boxes.
 - 4. Sprinklers.
 - 5. Irrigation accessories.
 - 6. Controllers.
- B. Evidence of State of Texas irrigation license and required experience.
- C. Shop Drawings: Show irrigation system piping, including plan layout, and locations, types, sizes, capacities, and flow characteristics of irrigation system piping components. Include water meters, backflow preventers, valves, piping, sprinklers and **rain sensors**, accessories, controls, and wiring. Show areas of sprinkler spray and overspray. Show wire size and number of conductors for each control cable.
- D. Operation and maintenance instructions.
- E. Spares and Special Tools – Provide Owner with 2 spare sprinkler heads of each size and type.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Installer – Installation of Irrigation System installation shall be performed under the direction of a State of Texas licensed irrigator with not less than 5 years experience in this type of work.

1.5 PRODUCT DELIVERY AND HANDLING

- A. Materials shall be delivered in manufacturer's unopened packaging labeled to indicate manufacturer's name and product identification. Ensure that packaging and labeling remain intact until installation. Materials shall be stored protected from the elements, including direct sunlight.
- B. Pipes shall be handled so as to prevent being damaged and to maintain their straightness. Pipe ends shall be wrapped. Pipes shall be stored on beds the full length of the pipes. Damaged or dented pipes or fittings shall not be used.

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 PIPES, TUBES, AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B), water tube, annealed temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- B. Hard Copper Tube: **ASTM B 88, Type K**, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

- C. Mainline PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedule 40.
 - 1. PVC Socket Fittings, Schedule 40: ASTM D 2466.
- D. Irrigation Lateral Line Pipe
 - 1. Pipes $\frac{3}{4}$ inch diameter and larger: ASTM D 2231, PVC, 1120 or 1220, SDR 21.0, 200 PSI
 - 2. Pipes $\frac{1}{2}$ inch diameter: ASTM D 2241, PVC, 1120 or 1220, SDR 13.5, 315 PSI
- E. FITTINGS FOR SOLVENT WELDED JOINTS
 - 1. Schedule 40: ASTM D 2466
 - 2. Schedule 80: ASTM D 2467
- F. FITTINGS FOR THREADED JOINTS
 - 1. ASTM D 2466, PVC, Schedule 80

2.3 GENERAL-DUTY VALVES

- A. Bronze Gate Valves: MSS SP-80, Class 125, Type 1, nonrising-stem, bronze body with solid wedge, threaded ends, and malleable-iron handwheel.
 - 1. Manufacturers:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Grinnell Corp.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Red-White Valve Corp.
 - h. Stockham.

2.4 REMOTE CONTROL VALVES

- A. Bronze Automatic Control Valves: Cast-bronze body, normally closed, diaphragm type with manual flow adjustment, and operated by 24-V ac solenoid.
 - 1. Manufacturers:
 - a. Buckner by Storm.
 - b. Ceres Products Corp.
 - c. Champion Irrigation Products.
 - d. Hasslinger Manufacturing Corp.
 - e. Hunter Industries Incorporated.
 - f. Netafim USA.
 - g. Rain Bird Sprinkler Mfg. Corp.
 - h. Superior Controls Co., Inc.

- i. Toro Company (The); Irrigation Div.
 - j. Weathermatic.
- B. Plastic Automatic Control Valves: Molded-plastic body, normally closed, diaphragm type with manual flow adjustment, and operated by 24-V ac solenoid.
 1. Manufacturers:
 - a. Buckner by Storm.
 - b. Ceres Products Corp.
 - c. Champion Irrigation Products.
 - d. Dig Corporation.
 - e. Hit Products Corp.
 - f. Hunter Industries Incorporated.
 - g. Irritrol Systems.
 - h. Nelson, L. R. Corporation.
 - i. Netafim USA.
 - j. Orbit Irrigation Products, Inc.
 - k. Rain Bird Sprinkler Mfg. Corp.
 - l. Toro Company (The); Irrigation Div.
 - m. Weathermatic.
- C. Automatic Drain Valves: Spring-loaded-ball type of **corrosion-resistant** construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig.
- D. Quick-Couplers: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, **yellow**, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.
 1. Manufacturers:
 - a. Buckner by Storm.
 - b. Ceres Products Corp.
 - c. Champion Irrigation Products.
 - d. Nelson, L. R. Corporation.
 - e. Rain Bird Sprinkler Mfg. Corp.
 - f. Toro Company (The); Irrigation Div.
 - g. Weathermatic.
 - h. Western Brass Works.
- E. Remote Control-Valve Boxes: Box and cover, with open bottom and openings for piping; designed for installing flush with grade. Include size as required for valves and service.
 1. Valve boxes shall be heavy duty plastic 17 inch by 11-3/4 inch by 12-inch depth, black with black cover. Valve box shall be Series 1419, non-hinged, non-bolt cover, by Carson Industries, Inc., 1925 Street, LaVerne, CA 91750, 213-732-6265, or approved equal.
 2. Valve boxes shall be heavy duty plastic 17 inch by 11-3/4 inch by 12-inch depth, purple with purple cover. Valve box shall be Series 1419, non-hinged, non-bolt cover, by Carson Industries, Inc., 1925 Street, LaVerne, CA 91750, 213-732-6265, or approved equal.

3. Valve boxes shall be precast concrete with compressive strength of concrete in excess of 4000 psi. Valve box shall be approximately 14 5/8" by 19 3/4" with bolt down cast iron traffic cover. Valve box shall be 36-T, by Brooks Products, or approved equal.
4. Manufacturers:
 - a. Armorcast Products Co.
 - b. Carson Industries LLC.
 - c. CDR Systems Corp.
 - d. Christy Concrete Products, Inc.
 - e. NewBasis.
 - f. Strongwell; Lenoir City Div.

F. Gate Valve and Control Wire Splice Boxes

1. Control wire splice boxes shall be heavy duty plastic 10-inch diameter by 10-1/4 inch deep, black with black cover, No. 910-12B, by Carson Industries, Inc. or approved equal.
2. Valve boxes for quick couplers, wire splices and gate valves shall be precast concrete with compressive strength of concrete in excess of 4000 psi. Valve box shall be 12 1/2 inch diameter by 10-1/2 inch deep, with cast iron cover. Valve box shall be No. 101, by Brooks Products, Inc. or approved equal.

G. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/8 inch minimum to 1 inch maximum.

2.5 SPRINKLERS

A. Description: Brass or plastic housing and corrosion-resistant interior parts designed for uniform coverage over entire spray area indicated, at available water pressure.

1. Manufacturers:
 - a. Buckner by Storm.
 - b. Ceres Products Corp.
 - c. Champion Irrigation Products.
 - d. Hit Products Corp.
 - e. Hunter Industries Incorporated.
 - f. Irritrol Systems.
 - g. K-RAIN Manufacturing Corp.
 - h. Nelson, L. R. Corporation.
 - i. Orbit Irrigation Products, Inc.
 - j. Rain Bird Sprinkler Mfg. Corp.
 - k. Senninger Irrigation, Inc.
 - l. Toro Company (The); Irrigation Div.
 - m. Weathermatic.
 - n. Western Brass Works.
2. Flush, Surface Sprinklers: Fixed pattern, with screw-type flow adjustment.
3. Bubblers: Fixed pattern, with screw-type flow adjustment.
4. Shrubbery Sprinklers: Fixed pattern, with screw-type flow adjustment.

5. Pop-up, Spray Sprinklers: Fixed pattern, with screw-type flow adjustment and stainless-steel retraction spring.
6. Pop-up, Rotary, Spray Sprinklers: Gear drive, full-circle and adjustable part-circle types.
7. Pop-up, Rotary, Impact Sprinklers: Impact drive, full-circle and part-circle types.
8. Aboveground, Rotary, Impact Sprinklers: Impact drive, full-circle and part-circle types.

2.6 SPRINKLER SPECIALTIES

- A. Strainer/Filter Units: Brass or plastic housing, with corrosion-resistant internal parts; of size and capacity required for devices downstream from unit.
- B. Emitters: PE or vinyl body.
 1. Manufacturers:
 - a. Agrifim.
 - b. Amiad Filtration Systems.
 - c. Aquapore Moisture Systems, Inc.
 - d. Buckner by Storm.
 - e. Dig Corporation.
 - f. Hit Products Corp.
 - g. Irritrol Systems.
 - h. Netafim USA.
 - i. NIBCO INC.
 - j. Olson Irrigation Systems.
 - k. Orbit Irrigation Products, Inc.
 - l. Rain Bird Sprinkler Mfg. Corp.
 - m. RAINDRIP Inc.
 - n. Salco Products, Inc.
 - o. Toro Company (The); Irrigation Div.
 2. Single-Outlet Emitters: To deliver the following flow at approximately 20 psig:
 - a. Flow: **1/2 gph.**
 - b. Tubing Size: 1/8-inch minimum ID and **10 feet** long.
 3. Outlet Caps: Plastic, for outlets without tubing.
- C. Drip Tubes: **NPS 1/2**, flexible PE or PVC tubing for emitters and other devices, of length indicated and with plugged end.
 1. Manufacturers:
 - a. Agricultural Products, Inc.
 - b. Agrifim.
 - c. Aquapore Moisture Systems, Inc.
 - d. Chapin Watermatics Inc.
 - e. Dig Corporation.
 - f. Drip In Irrigation Company.
 - g. Irritrol Systems.

- h. Netafim USA.
- i. NIBCO INC.
- j. Rain Bird Sprinkler Mfg. Corp.
- k. RAINDRIP Inc.
- l. Salco Products, Inc.

2.7 CONTROLLER(S)

- A. Controller(s) shall be Hybrid type Controller(s) as specified on drawings.
 - 1. Controller shall be a Hybrid type, capable of fully automatic or manual operation of the system.
 - 2. Controller shall operate on a minimum of 117 volts A.C. input power and be capable of operating 24 volt A.C. electric remote control valves. Controller shall have a reset circuit breaker to protect it from power overload.
 - 3. The controller shall have the specified number of stations. Each station shall have a time setting knob capable of being set for incrementally variable timing or set to omit the station from the irrigation cycle.
 - 4. Controller shall have a 365 day calendar, event day off, water budget, cycle and soak and a master “on-off” switch.
 - 5. Controller shall have a UL-listed 24V AC transformer. All station wiring shall be color-coded with section indicator key visibly imprinted.
 - 6. Operation instructions and location of water source supplying system shall be printed on face of controller. Section location chart shall be placed inside cabinet door.

2.8 CONTROLLER ENCLOSURE

- A. Exterior Control Enclosures shall be weatherproof, have locking door and provisions for grounding. Refer to plans for enclosure specifications.

2.9 WIRING

- A. Wiring: UL 493, Type UF-B multiconductor, with solid-copper conductors and insulated cable; suitable for direct burial.
 - 1. Manufacturers:
 - a. AFC Cable Systems Inc.
 - b. Alcatel Canada Wire, Inc.
 - c. American Electric Cable Co.
 - d. American Insulated Wire Corp.
 - e. Cerro Wire & Cable Co., Inc.
 - f. Colonial Wire and Cable Co., Inc.
 - g. Essex Group, Inc.; Building Wire Products Division.
 - h. Precision Cable Manufacturing Co., Inc.
 - i. Southwire Company.
 - j. Triangle Wire and Cable Co.

2. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers and runs over 1,000 LF.
3. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
4. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

2.10 BACKFLOW PREVENTERS

- A. Backflow Preventers shall be bronze and copper Reduced Pressure Backflow: Febco No. 825Y by Febco Sales, Inc. (CMB Industries), P.O. Box 8070, Fresno, CA 92747, 209-252-0791, or approved equal. Size as per drawings.

2.11 REMOTE CONTROL VALVE TIES

- A. Remote control valve ties shall be plastic tags with wire to attach numbered tag to valve.

2.12 SOLVENT CEMENT FOR SOLVENT WELDED JOINTS

- A. CHRISTY'S RED HOT BLUE GLUE T. Christy Enterprises, Inc., 1207 W. Struck Avenue, No. E, Orange, CA 92667, 800-258-4583, or approved equal. Use a compatible primer recommended by the solvent cement manufacturer.

2.13 SEALANT FOR THREADED JOINTS UNDER CONSTANT PRESSURE

- A. RECTOR SEAL LIQUID TEFLON by Rector Seal Corp., 2830 Produce Row, Houston, Texas 77023, 713-928-6423, or approved equal.

2.14 SLEEVES UNDER PAVING FOR CONTROL WIRE AND IRRIGATION LINES

- A. ASTM D 2455, PVC, Schedule 40 sized as shown on drawings.

2.15 FITTINGS FOR THREADED JOINTS

- A. ASTM D 2466, PVC, Schedule 80.

2.16 BACKFLOW ENCLOSURES

- A. The backflow enclosure shall be Strong Box model no. SBBC-30CR dark green as manufactured by V.I.T. Products, Inc., 800-729-1314.

2.17 RAINFALL MONITOR

- A. Refer to plans or approved equal.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
- B. Location of Heads – Design location is represented as accurately as possible. Make minor adjustments on site with approval of Landscape Architect as necessary to ensure consistent and even spacing where applicable. Set all heads minimum 6” from back of curb and 4” from edge of concrete walls.
- C. Install piping and wiring in sleeves under sidewalks, roadways, parking lots, and railroads.
- D. [Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 3 inches (19 to 75 mm) to 12 inches (300 mm) below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.]
- E. Provide minimum cover over top of underground piping according to the following:
 - 1. Irrigation Main Piping: Minimum depth of **18 inches** below finished grade.
 - 2. Circuit Piping: **12 inches**
 - 3. Drain Piping: **12 inches**
 - 4. Sleeves: **24 inches**
- F. BACKFILL - Backfill with clean material from excavation after obtaining Landscape Architect’s approval. Remove organic material, as well as rocks and debris larger than 1 inch in diameter. Place acceptable backfill in 6-inch lifts and water jet all trenches.
- G. EXISTING LAWNS – Where trenching is required across existing lawns, (or in even of changes or repairs after new lawn has been established), uniformly cut strips of sod 6 inches wider than trench. Remove sod in rolls of suitable size for handling and keep moistened until replanted.
 - 1. Backfill trench to within 6 inches of finished grade and compact. Continue fill with acceptable topsoil and compact to bring sod even with existing lawn.
 - 2. Replant sod within 2 days after removal, roll and water generously.
 - 3. Resod and restore to original condition all sod areas not in healthy condition equal to adjoining lawns 30 days after replanting.

3.2 INSTALLATION

- A. General - Unless otherwise indicated, Contractor shall comply with requirements of the governing Uniform Plumbing Code.

B. Pipes

1. Piping Mains and Laterals - Lay out sprinkler mainlines and perform line adjustments and site modifications to laterals prior to excavation. Lay pipe on solid subbase, uniformly sloped without humps or depressions.
2. PVC Pipe Assembly
 - a. Cut PVC pipe square and de-burr. Clean pipe and fittings using primer as recommended by the PVC pipe manufacturer. Use purple tinted primer to aid in visual inspection.
 - b. Apply a thin even flow coat of PVC solvent cement to inside of the fitting and pipe mating surface. Cure joints as recommended by the manufacturer and keep pipe and fitting out of service during curing period. Construct watertight joints equal or greater in strength than the pipe. Do not tap pipe at fittings.
3. Install plastic pipe in dry weather, when temperature is above 40 degrees F. and in accordance with manufacturer's written instructions. Allow joints to cure at least 24 hours at temperature above 40 degrees F. before testing.
4. Plastic pipe shall be snaked in the trenches in a manner to provide for expansion and contraction as recommended by pipe manufacturer.

C. Sleeves Under Paving - The majority of sleeves under paving are existing as shown on drawings. Where boring is required for new sleeves (refer to drawings), it shall be a "wet bore." Install sleeves 12" beyond edge of pavement. Perform trench and backfill in accordance with these specifications.

D. Irrigation Heads

1. Flush irrigation lines with full head of water and install heads after hydrostatic test is completed.
2. Install heads at manufacturer's recommended heights.
3. Locate part-circle heads to maintain a minimum distance of 4, 12, 24, 48 inches from walls and 2 inches from other boundaries, unless otherwise indicated.
4. Check for uniformity of coverage and pattern correctness. Adjust for 100% coverage where required.
5. Install nozzles with water running at reduced pressure starting with the head closest to the valve.
6. Adjust arcs and radius at normal operating pressure.

E. Drip Tubing

1. Tubing installed in planting beds is to be placed at spacing indicated on drawings in shallow trench and covered with planting backfill mix 1"-2" deep and then covered with mulch. Tubing is to be placed after bed preparation is complete and plant material is planted. Refer to Section 329300 – Plants.
2. Drip tubing is to be placed on top of root balls of trees in planting beds to allow for even watering of trees.
3. All tubing is to be reviewed by Owner's Representative prior to burying.

F. Electric Remote-Control Valves

1. Adjust automatic control valves to provide flow rate at rated operating pressure required for each irrigation section.
 2. Install valves in valve boxes, arranged for easy adjustment and removal. Locate valves to ensure ease of access for maintenance such that no physical interference with other elements of the project exist.
- G. Remote Control Valve Tags - One Remote Control Valve Tag shall be attached to stem of each electric remote-control valve. Tags shall be numbered sequentially. Numbers shall correspond to station numbers in electric controller. Provide tags and corresponding numbers for wires pulled for future valves.
- H. Valve Boxes - Install valve boxes to cover electric remote-control valves. Install one valve per valve box. Top of valve box shall be flush with finished grade. Bury minimum 4 bricks under base of each box as support.
- I. Control Wire Splice Boxes - Install control wire splice box to cover any splice in control wire. Top of valve box shall be flush with finished grade. Bury minimum 4 bricks under base of each box as support. Install control wire splice box to cover wires pulled for future valves.
- J. Gravel Backfill - Backfill valve boxes and control wire splice boxes with gravel, minimum 6 inch depth.
- K. Electric Controller
1. Controllers shall be fully grounded.
 2. Connect remote control valves to controller in clockwise sequence to correspond with stations 1, 2, 3, successively.
 3. Affix a non-fading copy of irrigation diagram to cabinet door below controller's name. Irrigation diagram shall be sealed between two plastic sheets, 20 mils. minimum thickness. Irrigation diagram shall show clearly all valves operated by the controller, showing station number, valve size, and type of planting irrigated.
 4. Provide galvanized padlock against vandalism. Provide two keys to Owner. Keys to be matched with existing controller keylocking mechanisms.
 5. Power to Controller & Locations: Locations shown on plan for controllers is approximate. Final location shall be determined on site by Owner. Contractor shall supply 120 VAC to controller from adjacent existing power sources. Follow local governing codes in electrical work.
- L. Irrigation Control Wires
1. Provide 24 volt system for control of automatic circuit-section valves of underground irrigation system. Provide unit capacity to suit number of circuits indicated.
 2. Install control wires with irrigation mains and laterals in common trench where possible. Lay control wires neatly together to side of pipe. Provide looped slack at valves, corners, bores and snake wire in trench to allow for contraction. Tie wires in bundles at 10-foot intervals. Line splices will be allowed on runs of 500 Ft. or more. Splices shall be made and placed in control wire splice boxes.
 3. Common ground wire shall be green. No other wires shall be green.

4. Supply one extra wire, for each direction of run, to valve which is located the greatest distance from the controller. Extra wire shall be white. Leave two loops of wire at each valve location.
5. Color of wire from controller to control valve shall be consistent to each valve.
6. Solder splices and protect with splicing material specified. Provide 12-inch-long expansion loop within 3 feet of each wire connection and splice on runs of wire 100 feet or longer.

M. Backflow Preventers

1. Make required connection to water supply according to local codes and manufacturer's written instructions.
2. Install pressure type backflow devices at required grade in accordance with the local Plumbing Code. Exposed mainline and mainline risers above PVC pipe main elevation shall be copper. Install one brass union in riser downstream of device.
3. Insulate all above ground piping.

3.3 TESTING

- A. General - Notify Landscape Architect 48 hours in advance when testing will be conducted. Conduct tests in presence of Landscape Architect.
- B. Hydrostatic Test - Test irrigation main line, before backfilling trenches, to a hydrostatic pressure of not less than 100 psi for 1 hour. Piping may be tested in sections to expedite work. Remove and repair or replace piping and connections which do not pass hydrostatic testing. System shall not lose more than 1-1/2 gallons of water in 1 hour.
- C. Shut off mainline at backflow preventer during non working hours until Contractor has demonstrated the mainline is stable.
- D. Operational Testing - Perform operational testing after hydrostatic testing is completed, backfill is in place and irrigation heads are adjusted to final position.
 1. Demonstrate to Landscape Architect that system meets coverage requirements, is a specified and indicated, and that automatic controls function properly.
 2. Coverage requirements are based on operation of one circuit at a time.
 3. After completion of grading, sodding and rolling of grass areas, carefully adjust lawn sprinkler heads so they will be flush with or not more than 1/2 inch above finished grade. Set shrub sprinkler heads not more than 1/2 inch above top of mulch.

3.4 MAINTENANCE

- A. Contractor shall correctly maintain the irrigation system during the installation process and throughout the landscaping maintenance service period. Specified in Section 329400 - Exterior Landscape Maintenance.
- B. Contractor shall provide "As Built" Drawings for new work, showing dimensioned location of valves, meters, backflow preventers, controllers, and mainline. Contractor shall request reproducible mylars from the Landscape Architect in preparation of "As Built" Drawings.

END OF SECTION 328400

SECTION 329201 - HYDROMULCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydromulch seeding.
2. Fertilization.

1.2 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of soil.
- B. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- D. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- E. Topsoil shall be friable clay loam surface soil reasonably free of clay lumps, stones, weeds, roots and other objectionable material, a product of on-site operations.
- F. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- G. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of grass seed.
1. Certification of each seed mixture for turfgrass sod: Certification shall be submitted from the supplier for each type of seed specified. Certification shall accompany the delivery of the seed and shall indicate that the seed is in accordance with the requirements of the local and state authorities.

- C. Fertilizer certification: Certification shall be submitted from the fertilizer manufacturer as to the chemical analysis of the fertilizer, a listing of the elements contained therein and their percentages. Certification shall also indicate that the fertilizer is in accordance with the requirements of the local and state authorities.

1.4 QUALITY ASSURANCE

- A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 1. Pesticide Applicator: State licensed, commercial.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B. Fertilizer Delivery: Fertilizer shall be delivered in the manufacturer's unopened containers, labeled to indicate the manufacturer's name and product identification. Containers shall be stored protected from ground contact and from the elements.

1.6 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Section 329301. Begin maintenance immediately after each area is planted and continue until acceptable turf is.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Type - Turfgrass seed shall be appropriate to season. The seed shall be harvested within 1 year prior to planting, free of Johnsongrass, field bind weed, dodder seed, and free of other weed seed to the limits allowable under the Federal Seed Act and applicable seed laws. The seed shall be extra fancy grade, treated with fungicide, and shall have a germination and purity that will produce, after allowance for Federal Seed Act tolerances, a pure live seed content of not less than 85 percent, using the formula: $\text{purity percent times (germination percent times plus hard or sound seed percent)}$. Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.

- B. Amounts

<u>Item</u>	<u>Rate Per 1000 Sq.Ft.</u>
Seed	As per season, see below
Fertilizer	12 lbs.
Water	As needed

- | | | |
|--|---------------------------------|---|
| | Real Virgin Wood
Fiber Mulch | Minimum 50 lbs. to achieve
covering of seeded area |
|--|---------------------------------|---|
- C. Spring/Summer Planting
(April 15 to Sept. 15)
Hulled Bermuda 2 lbs./1000 Sq. Ft.
- D. Fall/Winter Planting
(Sept. 15 to April 15)
Unhulled Bermuda 1 ½ lbs./1000 Sq. Ft.
KY Fesque 5 lbs./1000 Sq. Ft.
- E. Fertilize as per Paragraph B.
- F. Fertilizer for Fertilizing: (Tank Mix) shall be 13-13-13 grade, pelleted, uniform in composition, free-flowing, and suitable for application with approved equipment. The fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, conforming to the applicable state fertilizer laws, and bearing the name or trademark and warranty of the producer.
- G. Wood Cellulose Fiber Mulch: Wood cellulose fiber mulch, for use with the hydraulic application of grass seed and fertilizer, shall consist of specially prepared wood cellulose fiber. It shall be processed in such a manner that it will not contain germination or growth inhibiting factors. It shall be dyed an appropriate color to allow visual metering of its application. The wood cellulose fibers shall have the property of becoming evenly dispersed and suspended when agitated in water. When sprayed uniformly on the surface of the soil, the fibers shall form a blotter-like groundcover which readily absorbs water and allows infiltration to the underlying soil. Weight specifications from suppliers for all applications shall refer only to air dry weight of the fiber, a standard equivalent to 19 percent moisture. The mulch material shall be supplied in packages having a gross weight not in excess of 100 pounds and be marked by the manufacturer to show the dry weight content. Suppliers shall be prepared to certify that laboratory and field testing of their product has been accomplished and that it meets all of the foregoing requirements.
- H. Slurry Mix Components Per Acre:
- | | |
|----------------------------|--------------|
| Wood Cellulose Fiber Mulch | 2,000 pounds |
| Grass Seed | As Specified |
| Fertilizer (13-13-13) | As Specified |

PART 3 - EXECUTION

3.1 INSPECTIONS

- A. Surfaces indicated to be seeded shall be inspected to verify that all preparatory work in the area has been completed. Seeding shall not start until all preparatory work has been completed. Requests for inspections shall be made at least two days prior to anticipated date of inspection.

3.2 PREPARATION

- A. All areas to receive seed shall be stripped and/or treated with a contact herbicide prior to seeding as necessary to remove weeds, unless otherwise noted on drawings.
- B. Areas to receive seeding shall be loosened by manual or mechanical means to a depth of 1 1/2 inches, leveled and fine graded by hand raking. All stone (1" in diameter and larger in the top 2" of soil) are to be removed, tree stumps, brush, roots, vegetation, rubbish and other foreign matter shall be removed from the site. No foreign matter may be buried on the site. All tree stumps must be removed to a depth of two (2) feet below finish subgrade.

3.3 APPLICATION

- A. Special Mulching Equipment and Procedures: Hydraulic equipment used for the application of fertilizer, seed, and slurry of prepared wood fiber mulch shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry containing up to forty (40) pounds of fiber plus a combined total of seventy (70) pounds of fertilizer solids for each one hundred (100) gallons of water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles which provide even distribution of the slurry on the slopes to be seeded. The slurry tank shall have a minimum capacity of eight hundred (800) gallons and shall be mounted on a traveling unit which may be either self-propelled or drawn with a separate unit which will place the slurry tank and spray nozzles within sufficient proximity to the areas to be seeded so as to provide uniform distribution without waste. The Owner's Representative may authorize equipment with smaller tank capacity provided that the equipment has the necessary agitation system and sufficient pump capacity to spray the slurry in a uniform coat.
- B. Mixing: Care shall be taken that the slurry preparation takes place on the site of the work. Spraying shall commence immediately when the tank is full.
- C. Operators of hydromulching equipment shall be thoroughly experienced in this type of application. Apply specified slurry mix in a motion to form a uniform mat at specified rate. The operator shall spray the area with a uniform, visible coat by using the green color of the wood pulp as a guide. Keep hydromulch within areas designated and keep from contact with other plant material. Slurry mixture which has not been applied within four (4) hours of mixing shall not be used and shall be removed from the site.
- D. After installation, the Contractor shall not operate any equipment over the covered area. Immediately after application, thoroughly wash off any plant material, planting areas, or paved areas not intended to receive slurry mix. Keep all paved and planting areas clean during maintenance operations.
- E. Seeded Areas: If, in the opinion of the Landscape Architect, unplanted skips and areas are noted after hydromulching, the Contractor shall be required to seed the planted areas with the grasses that were to have been planted at no additional cost to the Owner.

3.4 MAINTENANCE OF HYDROSEEDED AREAS

- A. After installation, hydroseeded areas shall be watered in an amount and as often as necessary to keep seed beds moistened to their full depth for a period of 2 weeks.
- B. After initial 2 weeks of watering, seeded areas shall be watered and maintained to insure a healthy, vigorous growth throughout the installation period and the landscape maintenance period.

3.5 GUARANTEE

- A. A written guarantee shall be provided guaranteeing to maintain the treated areas in a healthy, vigorous, undamaged condition for a period of **60 days** beginning on the date of written acceptance of the work.
- B. Contractor shall guarantee a full stand of grass, 95% cover with no bare areas in excess of 6 inches diameter.
- C. Guarantee shall provide for timely filling, leveling and repairing eroded areas, reseeding areas exhibiting lack of healthy growth and mowing as necessary to maintain a neat appearance.

END OF SECTION 329201

SECTION 329202 - SODDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sod.
2. Fertilization.

1.2 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of soil.
- B. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- D. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- E. Topsoil shall be friable clay loam surface soil reasonably free of clay lumps, stones, weeds, roots and other objectionable material, a product of on-site operations.
- F. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- G. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of grass sod.
1. Sod Certification – Certification shall be submitted from the sod nursery as to the grass species, location of the field from which the sod has been stripped and the date of stripping. Certification shall accompany the delivery of the sod.

- C. Fertilizer certification: Certification shall be submitted from the fertilizer manufacturer as to the chemical analysis of the fertilizer, a listing of the elements contained therein and their percentages. Certification shall also indicate that the fertilizer is in accordance with the requirements of the local and state authorities.

1.4 QUALITY ASSURANCE

- A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 1. Pesticide Applicator: State licensed, commercial.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Sod Delivery - Sod shall be delivered on pallets with the root system protected from exposure to wind and sun. Stripping and delivery shall be timed so that sod will be placed within 48 hours of stripping.
- B. Fertilizer Delivery: Fertilizer shall be delivered in the manufacturer's unopened containers, labeled to indicate the manufacturer's name and product identification. Containers shall be stored protected from ground contact and from the elements.

1.6 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Section 329301. Begin maintenance immediately after each area is planted and continue until acceptable turf is established.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Sod shall be nursery grown **Common Bermuda** sod having a healthy, virile root system of dense, thickly matted roots throughout the soil of the sod for a minimum thickness of 1 inch. Sod shall be free of noxious weeds and undesirable native grasses. Soil attached to the sod shall be free of stones and debris.
- B. Sod shall have been mowed within 7 days of being stripped. Sod shall be provided in rectangular pads of not less than 12 inches nor more than 24 inches. Dry sod will be rejected.
- C. Fertilizer: shall be 13-13-13 grade, pelleted, uniform in composition, free-flowing, and suitable for application with approved equipment. The fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, conforming to the applicable state fertilizer laws, and bearing the name or trademark and warranty of the producer.

PART 3 - EXECUTION

3.1 INSPECTIONS

- A. Surfaces indicated to receive sod shall be inspected to verify that all preparatory work in the area has been completed. Sod installation shall not start until all preparatory work has been completed. Requests for inspections shall be made at least two days prior to anticipated date of inspection.

3.2 PREPARATION

- A. Strip existing vegetation and 1 inch of existing soil from all areas to receive sod not stripped and graded under previous work.
- B. After stripping, loosen soil to a depth of 2 inches prior to laying sod. Break up compacted soil. Remove all stones, roots, vegetation, rubbish, debris and other foreign matter 1" in diameter or larger from the top 2" of soil. No foreign matter may be buried on site.
- C. Hand rake to achieve a uniform loose depth to 2 inches and a smooth, consistent grade immediately prior to laying sod.
- D. Finish grade to be 1" below top of adjacent hardscape.
- E. Immediately prior to placing sod, apply the fertilizer and lightly moisten.

3.3 INSTALLATION

- A. All sod shall be carefully laid in parallel rows in a smooth manner, alternating all sod joints. Fit sod strips tightly together so that no joints are visible and tamp firmly. Cut pieces of sod to fill any voids left.
- B. Water sod immediately after planting, slowly but thoroughly, to secure at least six (6) inches penetration into the soil below the sod. Do not allow the blades of grass to wilt. The sodded area shall be thoroughly rolled in 2 directions to form a thoroughly even, solid mat. Any voids left in block sodding shall be filled with cut sod pieces and/or topsoil.
- C. Following the completion of the installation, the sod shall be watered in an amount and as often as necessary to maintain healthy growth of the grass.
- D. Treat entire areas of sod for fire ants during the 60-day maintenance period as per manufacturer's instructions and Section 329300, Plants.
- E. Apply second application of fertilizer 60 days after planting as per Section 329300, Plants.

3.4 MAINTENANCE OF SODDED AREAS

- A. Sodded area shall be maintained in good condition throughout the installation process and throughout the maintenance period as specified in Section 329301, Exterior Landscape Maintenance.
- B. Upon completion of work, clean areas within Contract limits, remove tools, supplies and equipment. Wash down curbs and pavement areas. Scrub curbs and walks as necessary to insure a clean surface. Provide site clean and free of materials and suitable for use as intended.

3.5 GUARANTEE

- A. A written guarantee shall be provided guaranteeing to maintain the treated areas in a healthy, vigorous, undamaged condition for a period of **60 days** beginning on the date of written acceptance of the work.
- B. Guarantee shall provide for timely filling, leveling and repairing eroded areas, reseeding areas exhibiting lack of healthy growth and mowing as necessary to maintain a neat appearance.

END OF SECTION 329202

SECTION 329300 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Plant drainage.

1.2 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Finish Grade: Elevation of finished surface adjacent to planting bed.
- C. Prepared Backfill Mix: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- F. Topsoil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots, the area of transition between the root system and the stem or trunk.
- H. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- I. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

1.3 SUBMITTALS

- A. Work Schedule: Contractor shall submit a work schedule for all planting work prior to purchase and installation of plant material.
- B. Product Data: For each type of product indicated, including soils.
- C. Samples of backfill mix.
- D. Samples of mulch.
- E. Product certificates.
- F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Including manufacturer's recommendations and instructions recommending procedures to be established by Owner for maintenance of planting work. Submit instructions prior to expiration of Contractor's required maintenance period.

1.4 QUALITY ASSURANCE

- A. Installer: Installation of planting work shall be performed by a single firm specializing in landscape and planting work. Contractor shall be licensed by the Texas Association of Nurserymen, shall possess an agricultural certificate, shall be a licensed pest applicator, and shall have not less than 5 years of experience in this type of work.
- B. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 1. Pesticide Applicator: State licensed, commercial.
- C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1. Provide healthy, vigorous stock, grown in recognized nursery in accordance with good horticultural practice and free of disease, insects, eggs, larvae and defects such as knots, sun-scald, injuries, abrasions or disfigurement.
- D. Delivery, Storage and Handling
 - 1. Compliance: Ship planting materials with Certificates of Inspection as required by governing authorities. Comply with all applicable local, state, and federal requirements regarding materials, methods of work, and disposal of excess and waste materials.
 - 2. Substitutions: Do not make substitutions unless approved in writing by Owner's Representative. If specified planting material is not obtainable, submit proof of non-availability to Owner's Representative together with proposal for use of equivalent material. Contractor shall submit proposal in a timely manner as to not impact project completion or installation of other work.
 - 3. Analysis and Standards: All packaged products shall be delivered in original manufacturer's sealed containers. For unpackaged materials, submit analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

4. Inspection: Notify Owner's Representative at least 2 weeks prior to installation, of location where materials that have been selected for planting may be inspected, either at place of growth or the site prior to planting. Plant material will be inspected for compliance with requirements for genus, species, variety, size and quality. Owner's Representative retains right to further inspect trees for size and conditions of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work. Contractor shall remove rejected trees immediately from site and replace with specified materials. Plant material not installed in accordance with Contract Documents will be rejected.

1.5 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.
 2. Warranty Periods from Date of **Substantial Completion**:
 - a. Trees, Shrubs, Vines, and Ornamental Grasses: **12 months**.
 - b. Ground Covers, Biennials, Perennials, and Other Plants: **12 months**.
 - c. Annuals: **Three months**.
 3. Remove and replace trees, shrubs and groundcover found to be dead or in unhealthy condition during warranty period. Replace trees, shrubs and groundcover which are in doubtful condition at end of warranty period. However, if in the opinion of Owner, such doubtful material may survive, Contractor shall extend the warranty period for a full growing season. Owner will determine which items are in doubtful condition.

1.6 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Begin maintenance immediately after plants are installed throughout the maintenance period. See Section 329301 – Exterior Landscape Maintenance
 1. Maintenance Period for Trees and Shrubs: **60 days** from date of **Substantial Completion**.
 2. Maintenance Period for Ground Cover and Other Plants: **60 days** from date **Substantial Completion**.
 3. Maintenance Period for New Lawns: **60 days** from date of **Substantial Completion**.

1.7 JOB CONDITIONS

- A. Work Scheduling: Proceed with and complete planting work in a timely manner, working within seasonal limitations for each kind of planting work required.
- B. Planting Time
 - 1. Correlate planting with specified maintenance periods to provide maintenance from date of Substantial Completion.
 - 2. Plant frost-tender trees only after danger of frost is past or sufficiently before frost season to allow for establishment before first frost. Do not plant in frozen ground.
 - 3. Plant trees, shrubs and groundcover after final grades are established and prior to planting of lawns, unless otherwise directed by Owner's Representative in writing. If planting occurs after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.
- C. Utilities: Refer to drawings and coordinate with Utility Contractor for location of utilities. Contractor shall be responsible for damage to existing utilities and structures.
- D. Security: The Owner will not assume any responsibility for security of any materials, equipment, etc. during construction of the project until project acceptance.
- E. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions beyond the scope of this contract, or obstructions, notify Owner's Representative of such conditions, immediately and before planting.
- F. Pollution Control: Control dust caused by planting operations. Dampen surfaces as necessary. Comply with pollution control regulations of governing authorities.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

2.2 FERTILIZERS

- A. **Fertilizer for planting areas shall be a commercial all organic, all-natural biological fertilizer, which includes humates, rock minerals, bio-inoculants and bio-stimulants. Fertilizer shall be granular, uniform in composition, free flowing, and suitable for application with approved equipment. Fertilizer which has been exposed to high humidity and moisture, has become caked or otherwise damaged making it unsuitable for use, will not be acceptable. Fertilizer shall be Microlife Ultimate (8-4-6) as manufactured by San Jacinto Environmental Supply, 2221 A West 34th Street, Houston, TX 77018, 713-**

957-0909, or approved equal. Fertilizer shall be mixed into the planting mix at the rate of 5 lbs. per cu. Yd.

- B. Plant tablet shall be Agriform 20-10-5 Planting Tablets shall be evenly placed in planting pits at the following rate:

<u>Material</u>	<u>No. of Tablets</u>
1 gallon/4" pots	1/2 (or granular fertilizer)
5 gallon	1
15 gallon	2
30 gallon	3
Greater than 30 gallon	1 – for each ½ inch

- C. **Additional Microlife Ultimate fertilizer shall be evenly dispersed through soil in planting pits at the following rate:**

<u>Material</u>	<u>No. of ounces per planting pit</u>
30 gallon	3
65 gallon	6]

2.3 PLANTING SOILS

- A. **Prepared Backfill Mix: Shall be 33% topsoil, 33% sharp sand, and 33% enriched bark mulch or approved commercially available soil mix. Add fertilizer as per specifications.**

- B. Compost for bed prep/soil backfill mix shall be leaf mold compost as supplied by Nature’s Way Resources, Inc., Conroe, Texas or approved equal. Compost shall be and organic compost free from deleterious materials, 100% composted vegetative material and horse. Compost must be made from organic materials approved by the State of Texas as specified in Chapter 332 of the Health & Safety Code as listed in the Texas register. Compost must contain less than 1% by dry weight of inert contaminants such as glass, plastic, rocks, etc. Industrial or hazardous waste can not be used in the production of the compost (i.e. boiler ash, rice hull ash, etc.). Compost shall be free of fillers such as rice hulls or pine bark. Compost shall not exceed the heavy metal limits as specified in the US EPA Part 503 Regulations.

1. Contractor shall furnish copies of manufacturer’s literature, certifications, sources, samples, or laboratory analytical data for the following items: Certificates of inspection required for transportation shall accompany each shipment of materials. Provide certificates to Owner’s Representative.
2. Testing:
 - a. Chemical and Physical - All compost components shall be tested by the following testing laboratories for conformity to the specifications:
 - b. Texas Plant and Soil Lab, 5115 West Monte Cristo, Edinburg, Texas 78539, (956) 383-0739; A&L Plains Agricultural Laboratories, Inc., 302 34th Street, Lubbock, Texas 79404, (806) 763-4278; Soil and Plant Laboratory, Incorporated, Post Office Box 153, Santa Clara, California 95052, (408) 243-0330.
 - c. Biological: Soil Food Web. 1128 NE 2nd Street, Suite 120, Corvallis, Oregon 97330, (541) 752-5066.
 - d. If herbicide contamination is suspected, then a radish/rye-grass growth trial must be performed. For delivered material, test one grab sample for each fifty (50) cubic yards of bulk material delivered to the site. Testing will be at the expense of Contractor. Deviations greater than plus or minus twenty (20%) percent from

control data may be grounds for rejection of mixes tested. Non-conforming materials shall not be used and shall be removed from the site.

3. Biological, physical and chemical specifications:
 - a. Specifications: Stability/Maturity (Carbon Dioxide Evolution Rate) Shall be less than 8 mg CO₂-C per g OM (organic matter) per day and greater than 6.0 on the Solvita™ Compost Maturity Test.
 - b. Biological components:

Bacteria (active) - minimum of 15-25 micrograms per gram of compost; Bacteria (total) - minimum of 150 micrograms per gram of compost; Fungus (active) - minimum of 15-25 micrograms per gram of compost; Fungus (total) - minimum of 150 micrograms per gram of compost; Fungus (hyphal diameter) – should be greater than 1 mm; Protozoa: flagellates - 8,000 or higher per gram of compost; amoebae - 8,000 or higher per gram of compost; ciliates - 50-100 or higher per gram of compost; Root Feeding Nematodes should not be present (beneficial nematodes are a benefit)
 4. PHYSICAL Specifications: Moisture Content - 30-60%, wet weight basis; Moisture Holding Capacity - 75-200% of dry weight; Organic Matter Content - 30-70% (40-50% preferred), dry weight basis; Particle Size: Standard Grade Compost - 100% passing through a 1” rectangular mesh screen or smaller; Fine Grade Compost - 100% passing through a 3/8” rectangular mesh screen or smaller; Bulk Density - 700-1,200 (800-1,000 preferred), pounds per cubic yard; Electrical Conductivity (Soluble Salt Concentration) - 10 dS/m max., (2.0-3.6 or less preferred).
 5. CHEMICAL Specifications: pH 6.0-8.5; Total Salinity-2,000 ppm or lower; Chemical components (H₂O extraction): Nitrogen-10 ppm or higher, Phosphorus-100 ppm or higher, Potassium- 400 ppm or higher, Calcium-2000 ppm or higher, Magnesium-200 ppm or higher, Zinc-6 ppm or higher, Iron-25 ppm or higher, Manganese - 8 ppm or higher, Copper-1 ppm or higher, Sodium-1000 ppm or less, Sulfur-10 ppm or higher Boron-1 ppm or higher.
- C. Topsoils
1. Provide topsoil which is fertile, friable, natural loam, surface soil, free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 2 inches in any dimension and other extraneous or toxic matter harmful to plant growth.
 2. Obtain topsoil only from naturally, well-drained sites where topsoil occurs in a depth of not less than 4 inches. Topsoil shall not be collected from sites that are infected with growth of, or the reproductive parts of noxious weeds, especially nut grass. Topsoil shall not be stripped, collected or deposited while wet. Topsoil shall not be excessively acid or alkaline or contain toxic substances which may be harmful to plant growth. Topsoil shall be without admixture of subsoil.
- D. Compost Mulch for bed preparation shall be Organic mulch free from deleterious materials and suitable for top dressing of trees, shrubs or plants. Mulch shall be composted, well-rotted, blended double-shredded hardwood mulch, black or dark brown in color. Mulch pieces shall be sized to pass through a 1” screen. Compost mulch: Enriched bark mulch for bed prep shall be With additional organic of peat and/or manure. No dyes, mushroom compost or other additives shall be used to artificially enhance the appearance of the level of composting.
- E. Sharp Sand: Sand shall be thoroughly washed, coarse, graded sharp, construction or brick sand, free of clay balls, weeds, and grass. So-called cushion sand, blow sand, or creek silt is not acceptable for substitution where sharp sand is specified.

2.4 MULCHES

- A. **Mulch for Top Dressing: Shredded hardwood, Wood and bark chips. Organic mulch free from deleterious materials and suitable for top dressing of trees, shrubs or plants. Mulch shall be composted, well-rotted, blended double-shredded hardwood mulch dark brown in color. Mulch pieces shall be sized to pass through a 1" screen. No dyes, mushroom compost or other additives shall be used to artificially enhance the appearance of the level of composting. Mulch shall be Native Hardwood Mulch as supplied by Natures Way Resources, 101 Sherbrook Circle, Conroe, TX, or approved equal.**
- B. **Mineral Mulch: [Rounded riverbed gravel or smooth-faced stone] [Crushed stone or gravel] [Marble chips] [Granite chips] <Insert stone type>.**
 - 1. Size Range: **3/4 inch maximum, 1/4 inch minimum.**
 - 2. Color: **Uniform tan-beige color range acceptable to Architect.**

2.5 WEED-CONTROL BARRIERS

- A. **Weed Barrier: Woven soil separator/weed barrier to be installed on the path system shall be Pro 5 Weed Barrier as manufactured by DeWitt Company.**

2.6 PLANTING DRAINAGE

- A. **Drainage Gravel: Drainage gravel shall be 3/4" – 1" diameter clean washed gravel.**
- B. **Decomposed Granite: The decomposed granite shall be pink in color.**

2.7 PESTICIDES

- A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.8 HERBICIDE

- A. Pre-emergent herbicide shall be Team Pro as manufactured by Bonus Corp Fertilizer, Houston, TX, or approved equal. Apply pre-emergent over all planting areas prior to spreading mulch at the rate of 7 lbs./1000 sq. feet.
- B. If necessary, contact herbicide shall be Roundup by Monsanto, 800 N. Lindbergh, St. Louis, MO 63167, 314-694-1000, or approved equal. Apply Roundup only if necessary and if approved by owner or owner's representative. Do not exceed manufacturer's recommended rate of application.

2.9 STAKING AND GUYING

- A. Reference drawings for staking and guying material.

PART 3 - EXECUTION

3.1 PLANTING

A. Excavation for Trees and Large Shrubs

1. Excavate pits with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. Rough up sides of pit.
2. Make excavations at least half again as wide as the ball diameter and equal to the ball depth, plus 4" allowance for setting of ball on a layer of compacted backfill.
3. Dispose of subsoil removed from planting excavations. Do not mix with planting soil or use as backfill.

B. Planting Trees and Large Shrubs

1. Set stock on layer of compacted prepared planting soil backfill mix, plumb and in center of pit at same elevation as adjacent finished planting grades. Distribute additional fertilizer evenly throughout backfill mix in hole at specified rate. Place prepared planting soil backfill mix around base and sides of ball and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill. For trees, apply Tree Inoculant at rate specified according to size of tree. Repeat watering until no more water is absorbed. Dish top of backfill to allow for mulching.
2. Prune, thin out, and shape shrubs in accordance with standard horticultural practice. Prune shrubs to retain natural character. Remove and replace excessively pruned or misformed stock resulting from improper pruning.
3. Stake and guy trees as per the drawings.

C. Excavation and Soil Preparation for Shrubs/Groundcovers in Planting Beds

1. **Excavate entire planting beds to a depth of 8 inches. Planting beds to have vertical sides.**
2. **Dispose of subsoil removed from planting beds excavations. Do not mix with planting soil or use as backfill.**
3. **Till bottom of planter 2"-4", leave bottom of planter un-compacted. Backfill with 8" of prepared backfill mix.**

D. Planting of Trees and Shrubs in Beds

1. **Set stock on layer planting soil mixture, plumb and at the same elevation as adjacent finished planting grades. Place fertilizer tablets paced in planting bed at specified rate. Place additional backfill mix around base and sides of ball and work each layer to settle backfill and eliminate voids and air pockets. Water entire bed thoroughly, adjusts plant if settling occurs.**

Planting of Shrubs in Beds

1. **Set stock on layer of prepared planting soil backfill mix, plumb and slightly above adjacent finished planting grades. Place additional prepared planting soil backfill mix around base and sides of ball and work each layer to settle backfill and eliminate voids and air pockets. Layer and distribute additional fertilizer in planting hole at specified rate. Water entire bed thoroughly, adjusting plant if settling occurs.**

3.2 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.
- B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use practices to minimize the use of pesticides and reduce hazards.
- D. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- E. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

END OF SECTION 329300

SECTION 329301 - EXTERIOR LANDSCAPE MAINTENANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and all applicable specification sections, apply to this section.

1.2 WORK COVERED

- A. Furnish all labor, materials and equipment as necessary to provide a landscape maintenance program in strict accordance with the Specifications and Drawings as prepared by LJA Engineering, Inc.

1.3 RELATED WORK IN OTHER SECTIONS

- A. Examine all section for work related to this section.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

- A. Perform Work in accordance with all applicable laws, codes, and regulations required by authorities having jurisdiction over such work and provide for all permits required by local authorities.

1.5 CONTRACTOR RESPONSIBILITIES

- A. The Contractor shall begin maintenance immediately upon starting any portion of the Work of this contract.
- B. The Contractor's Maintenance Period shall continue **60 days** beyond **Substantial Completion** of all Work in this contract.
- C. Trees, Shrubs and Groundcovers: The Contractor's maintenance of new planting shall consist of watering, cultivating, weeding, mulching, re-staking, tightening and repairing of guys, resetting plants to proper grades or upright position, restoration of the planting saucer, and furnishing and applying such sprays and invigorants as are necessary to keep the plantings free of insects and disease and in thriving condition.
- D. Irrigation System: Maintenance of irrigation system shall consist of monitoring and adjustment of the duration and frequency of the watering schedule, adjustment of heads for coverage and elevation, repair of leaks in both mains and lateral lines and all other work required to establish a complete working irrigation system.
- E. Lawns: Maintenance of new lawns shall consist of mowing, watering, weeding, repair of all erosion and reseeding as necessary to establish a uniform stand of specified grasses.
- F. Trash Pick-up: Pick up trash on site and empty trash receptacles at each site visit.

1.6 PROTECTION

- A. Protect planting areas and lawns at all times against damage of all kinds for duration of maintenance period. Maintenance includes temporary protection fences, barriers and signs as required for protection. If any plants become damaged or injured, because sufficient protection was not provided, treat or replace as directed by Owner at no additional cost to Owner.

1.7 FINAL ACCEPTANCE

- A. Work under this section will be accepted by Landscape Architect upon satisfactory completion of all work, including maintenance, replacement of plant materials and lawns under the Warranty Period. Upon final Acceptance, the Owner will assume responsibility for maintenance of the Work.

1.8 WARRANTIES AND REPLACEMENTS

- A. Refer to other sections.

1.9 MAINTENANCE INSTRUCTIONS

- A. At the completion of work, furnish two (2) copies of written maintenance instructions to Owner and one (1) copy to Landscape Architect for maintenance and care of all planting throughout the year.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials required for installed items shall match those already in use.
- B. Samples of all materials not specified under other sections of these Specifications shall be submitted for review by Landscape Architect prior to use.
- C. Topdress Fertilizer: Commercial fertilizer with guaranteed analysis of 16-6-8 or as required for application use. Fertilizer shall have a salt index per nutrient of less than 65.

2.2 REQUIRED EQUIPMENT

- A. Contractor shall have available for their use the following maintenance equipment:
 - 1. Lawn Mowers
 - 2. Gasoline Powered Edgers
 - 3. Trash Collection Equipment
 - 4. Line Trimmers
 - 5. Miscellaneous Hand Tools, Rakes, Brooms, Etc.
 - 6. Blowers
 - 7. Other as needed.

PART 3 - EXECUTION

3.1 WATERING

- A. It shall be the responsibility of the Contractor to assure that the correct watering of plant materials is being accomplished through the following irrigation techniques:
- B. Regular deep watering to all new trees until there are definite signs that the trees have established themselves, new growth is apparent, and no trees are experiencing stress conditions.
- C. Frequent watering to the lawn areas to insure against drying. This may be accomplished as above, by the automatic sprinkler system, hand watering or portable sprinklers. Contractor shall monitor settings of automatic sprinkler controls and recommend necessary adjustments according to climatic changes.
- D. Contractor shall be responsible for watering areas within the project limits that do not have irrigation systems.
- E. Contractor shall be responsible for damages to irrigation system caused by maintenance operations.

3.2 MAINTENANCE OF TURF AREAS

- A. Mowing lawn/grass areas shall be accomplished with sharp, properly adjusted mowers of the correct size for the various areas.
- B. Mowing frequency shall be as per the Landscape Maintenance Program. Blade heights shall be set according to the following schedule.
 - 1. 1 ½ inches Initial Mowing
 - 2. 1 ½ inches April – November
 - 3. 2 inches December – March
- C. In the event of a prolonged rainy period and a surge of leaf growth is anticipated, the mower height may be readjusted to prevent “scalping” or skinning of lawn on preceding cuts.
- D. Lawn shall be edged evenly at all walks, headers and other structures as per the schedule. Use an edger, not a line trimmer.
- E. Until the establishment of the turf, the Contractor will be responsible for replacing soils that have eroded onto the paved areas. Residual soils on paving will be removed and if not mingled with objectionable materials may be re-used in eroded areas.
- F. Immediately upon observing any lawn grass spreading into shrub or groundcover areas, the Contractor shall initiate a program of removal and maintain this program throughout the maintenance period.
- G. Any lawn grass appearing in paved areas shall receive an application of soil sterilant according to manufacturer’s direction. The sterilant shall be approved and will not be detrimental structurally to paved areas.
- H. Special effort shall be given to the control to fire ants infesting the site. After control is accomplished, the ant mounds shall be lowered and tamped to the existing grade.

- I. Apply top dress fertilizer after grassing, if needed.

3.3 MAINTENANCE OF TREES AND SHRUBS

- A. Contractor shall adjust and tighten as required all tree staking and guying. Removal as directed by Owner's Representative.
- B. All weeds within the mulched area around each tree and in each shrub bed shall be removed as often as required. Under no circumstances shall weeds and grass within planted areas be allowed to attain more than 4 inches growth.
- C. Contractor shall be continuously alert for signs of insect presence or damage or the presence or damage from plant fungi. Upon locating such evidence, the Contractor shall report it to the Owner's Representative and take action as directed.

3.4 MAINTENANCE OF IRRIGATION SYSTEM

- A. Irrigation System: Maintenance of irrigation system shall consist of monitoring and adjustment of the duration and frequency of the watering schedule, adjustment of heads for coverage and elevation, repair of leaks in both mains and lateral lines and all other work required to establish a complete working irrigation system.

3.5 TRASH COLLECTION

- A. Removal of debris from the site unrelated to horticultural maintenance (paper, bottles, can, "Pirate" signs, etc.) shall be the responsibility of the Contractor. Contractor shall pick up trash and empty trash receptacles at each site visit. Frequency as per Landscape Maintenance Program.

3.6 DE-WATERING

- A. Contractor shall de-water by pumping or siphoning as often as necessary to remove excess moisture from soil in planting areas and tree balls. De-watering to occur during scheduled visits as required.

PART 4 - SCHEDULES

- 4.1 THE EXECUTION ITEMS OF PART 3 IN THIS SPECIFICATION SHALL BE PERFORMED AS PER THE FOLLOWING SCHEDULE AS APPLICABLE FOR THE MAINTENANCE PERIOD:

<u>MONTH</u>	<u># OF VISITS PER MONTH</u>
January	2
February	2
March	4
April	4
May	5
June	4
July	5
August	5
September	5
October	3

November	2
December	2

4.2 TOPDRESS FERTILIZER

- A. Thirty (30) days after seeding.

4.3 MULCHING, WEEDING, WEED CONTROL, GUYING AND STAKING ADJUSTMENT

- A. As required at each visit.

4.4 MEETING

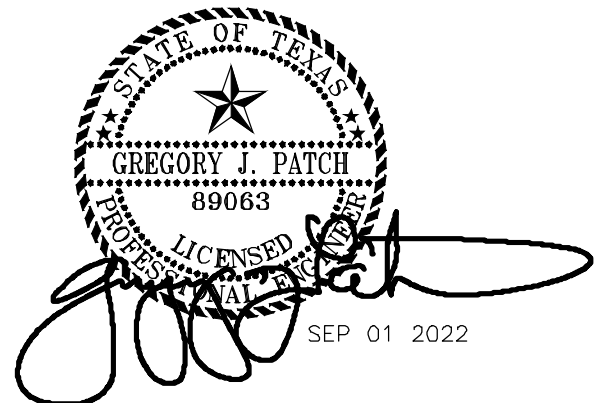
- A. Contractor shall meet once each month and at the end of the maintenance period with the Owner's on-site maintenance personnel. Contractor shall review irrigation system schedule and operation and other pertinent and helpful maintenance information at each meeting.

END OF SECTION 329301

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ITEM 102

CLEARING AND GRUBBING

102.1 Description. This Item shall govern for conducting clearing and grubbing operations within the project limits from right-of-way line to right-of-way line. For the purpose of this Item, the project limits shall include roadways, roadside ditches, channels, outfall ditches, detention ponds, and other drainage facilities, temporary and permanent easements and other areas as shown on the drawings. Clearing shall consist of removing all trees, brush, overhangs, logs, tires, appliances, trash, rubbish and other debris, including any deleterious materials, that exist within the limits of the project. Grubbing shall comply with the requirements of the third paragraph of Section 102.2 below.

It shall be the responsibility of the Contractor to visit the project site and ascertain the clearing and grubbing requirements as included in the bid documents prior to submitting a bid on the project. Any necessary trimming of overhangs that encroach into the right-of-way and interfere with the facilitation of construction or the operation or maintenance of the executed project shall be required and will not be paid for separately.

102.2 Construction Methods. The project limits shall be cleared of all trees, brush, stumps, overhangs, logs, rubbish, shrubs, and other trash. Items and certain areas designated by the Engineer for preservation shall be carefully protected from abuse, marring or damage during construction operations and preserved in accordance with the bid documents.

Parking and/or servicing of equipment, or stockpiling of construction materials within 3 feet of the drip line of trees designated for preservation, will not be permitted.

On areas required for roadway, detention pond, channel, or structural excavation, grubbing shall be conducted to remove all stumps, roots, etc., to a depth of approximately 2 feet below the lower elevation of the excavation. On areas required for embankment construction, grubbing shall be conducted to remove all stumps, roots, etc., to a depth of approximately 2 feet below the existing ground surface. All holes remaining after clearing and grubbing shall be backfilled with suitable onsite material and compacted to 95 percent of Standard Proctor Density (ASTM D698 "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)") at a moisture content of between optimum and +/- 3 percent of optimum as directed by the Engineer and the entire area bladed to prevent ponding of water and to provide drainage; except in areas to be immediately excavated, the Engineer may direct that the holes not be backfilled. On

areas required for borrow sites and material sources, stumps, roots, etc., shall be removed to the complete extent necessary to prevent such objectionable matter becoming mixed with the material to be used in construction.

- 102.3 Disposal of Materials. All cleared and grubbed materials shall be disposed of offsite. The Contractor shall be responsible for obtaining any necessary disposal permits. The Contractor shall not bury any refuse on Harris County property. The disposal site shall not be an environmentally sensitive area, "Waters of the United States", wetland, or floodway. It is the responsibility of the contractor to contact the proper authorities to determine land use classification and to obtain any necessary permits. If the disposal site is defined in the plans, then the County shall be responsible for ensuring that the appropriate Department of the Army permit has been obtained for the activity, as necessary. No burning shall be allowed unless otherwise noted.

The Contractor shall refer to Item 560 "Maintenance and Cleanup of the Project Site" for schedule and frequency of cleanup of materials for disposal.

- 102.4 Limit of Operation. No clearing or grubbing shall be done outside the Project limits or the right-of-way. Any work done outside the Project limits or the right-of-way limits, for any purpose, shall be done at the Contractor's expense and it shall be the Contractor's responsibility to negotiate and secure the permission of the property owner for such operation. The Contractor shall provide sufficient evidence to Harris County that such permission has been obtained.

- 102.5 Schedule of Clearing. The Contractor shall schedule his clearing operations so that clearing has been completed for a distance of 2,000 feet ahead of any point where excavation is to be started. After starting excavation, the Contractor shall keep a minimum of 1,000 feet of cleared right-of-way ahead of the excavation operation.

- 102.6 Measurement & Payment. Clearing and grubbing will be paid for at the unit price bid per lump sum, acre, or station (100 foot), as designated in the proposal and/or drawings, and shall be full compensation for furnishing all labor, materials, permits, supervision, equipment and supplies required to complete all items of work specified herein.

Removal of concrete structures shall be measured and paid for in accordance with Item 104 "Removing Old Concrete" and Item 495 "Removing Old Structures".

Tree protection and tree trimming shall be measured and paid for in accordance with Item 501 "Tree Protection and Trimming".

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 104 "Removing Old Concrete"

Item 200 "Stripping"

Item 495 "Removing Old Structures"

Item 501 "Tree Protection and Trimming"

Item 560 "Maintenance and Cleanup of the Project Site"

END OF ITEM 102

ITEM 104

REMOVING OLD CONCRETE

104.1 Description. This Item shall govern for breaking up and satisfactorily disposing of concrete pavement, slope paving, riprap, median strips, driveways, sidewalks, combined curb and gutter, or curb.

104.2 Construction Methods. Existing concrete to be disposed of, consisting of pavement, slope paving, riprap, median strips, driveways, sidewalks, combined curb and gutter or curb, shall be removed and legally disposed of offsite. The use of explosives for breaking up old concrete will not be permitted, unless authorized by the Engineer, and when so authorized, adequate precautions shall be given to prevent damage to adjacent property. Reinforcing steel shall be cut as necessary for satisfactory disposal.

Where only a portion of the existing concrete is to be removed, special care shall be exercised to avoid damage to that portion of the concrete to remain in place. The existing concrete shall be cut to the neat lines shown on the plans or established by the Engineer and any existing concrete, beyond the neat lines so established, which is damaged or destroyed by these operations shall be replaced at the Contractor's entire expense. Saw-cutting, full depth or as shown on the drawings, will be required and shall be incidental to the removal of old concrete.

Where indicated on the plans, old concrete which is removed shall be loaded, hauled and disposed of at permitted locations outside the project limits, or used as needed for riprap onsite. Broken concrete reused as riprap onsite will be incidental to this Item. The Contractor shall provide the disposal locations and the total quantity of all excavated material, and the total quantity of disposed material. The disposal site shall not be an environmentally sensitive area, "Water of the United States", wetland, or floodway. It is the responsibility of the Contractor to contact the proper authorities to determine land use classification and to obtain any necessary permits. If the disposal site is defined in the plans, then the County shall be responsible for ensuring that the appropriate Department of the Army permit has been obtained for the activity, as necessary.

Work performed under this Item shall be initiated at such time and prosecuted in such a manner as to cause a minimum of inconvenience to traffic or adjacent property owners.

104.3 Measurement. Existing concrete pavements with or without curbs, slope paving, driveways, sidewalks, median strips, and riprap, removed as

prescribed above, will be measured by the square yard in its original position, regardless of its thickness or the depth of covering.

Existing combined concrete curb and gutter and concrete curb, not on concrete pavement, removed as prescribed above will be measured by the linear foot in its original position, regardless of the dimensions of same. Monolithic concrete curb or doweled-on concrete curb will be considered as part of the concrete pavement to be removed and will not be measured separately.

104.4 Payment. The work performed as prescribed by this Item, measured as provided under "Measurement" will be paid for at the unit price bid for "Removing Old Concrete" (of the type specified), which price shall be full compensation for:

- A. Full depth saw-cutting or
- B. Partial depth saw-cutting and breaking up the concrete,

cutting reinforcing steel when required, loading, hauling and disposing of the material offsite and for all labor, tools, equipment, manipulations and incidentals necessary to complete the work.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 205 "Subgrade"

END OF ITEM 104

ITEM 110

EXCAVATION

110.1 Description. This Item shall govern the required excavation within the limits of roadway including roadway ditches (excluding excavation designated as channel excavation, structural excavation, etc.), the removal and proper utilization or disposal of all excavated materials; including stripping and the constructing, shaping and finishing of all earthwork on the entire length of roadway and the approaches to same, in conformity with the required lines, grades and typical cross-section and in accordance with the requirements herein outlined. Stripping is unsuitable material. All suitable excavation material shall be used for embankment, prior to using borrow material. Compaction of embankments shall be as outlined in the Item 132 "Embankment". The roadway is defined as being from right-of-way line to right-of-way line, within the limits of the project.

110.2 Construction Methods. All roadway excavation and corresponding embankment construction shall be performed as specified herein and in accordance with the Item 132 "Embankment" and the completed roadway shall conform to the established alignment, grades and cross-sections.

All suitable excavated materials shall be utilized, insofar as practicable, in constructing the required roadway sections or in uniformly widening embankment, flattening slopes, etc., or as directed by the Engineer. Suitable materials will be defined by the Engineer. Unsuitable roadway excavation and roadway excavation in excess of that needed for construction shall be known as waste and shall become the property of the Contractor to be disposed of by the Contractor outside the limits of the right of way, in a legal manner. Stripping shall be considered as unsuitable material and shall be disposed of by the Contractor.

The disposal site shall not be an environmentally sensitive area, "Water of the United States", wetland, or floodway. It is the responsibility of the Contractor to contact the proper authorities to determine land use classification and to obtain any necessary permits. If the disposal site is defined in the plans, then the County shall be responsible for ensuring that the appropriate Department of the Army permit has been obtained for the activity, as necessary. Unsuitable material encountered below subgrade elevation, shall be replaced with suitable material from the roadway excavation, or with other suitable material sources.

During construction, Item 560 "Maintenance and Cleanup of the Project Site" shall be implemented for the duration of the Contract. The roadbed and ditches shall be maintained in a condition to insure proper drainage at all times. Ditches and channels shall be so constructed and maintained as to avoid damage to the roadway section.

All roadway excavation utilized as embankment shall be placed in accordance with Item 132 "Embankment".

In those cases where the Contractor has over-excavated beyond the lines and grades shown on the drawings, or designated by the Engineer, it shall be the Contractor's responsibility to replace the material and recompact it at his own expense. The material shall be replaced in accordance with the Item 132 "Embankment".

At the location of pipeline crossings, the Contractor shall suspend machine excavation at location within 5 feet of any pipeline right of way, until a company representative is present to identify pipeline locations and to further direct excavation operations. The notification to the pipeline company of the Contractor's operations and the request for their representative's attendance shall be the responsibility of the Contractor. The Contractor shall not be reimbursed directly for any work or expenditure as a result of intersecting any pipeline operation. Any contingent costs therefore shall be anticipated in the preparation of the bid and included as distributed items of cost in the price for roadway excavation.

110.3 Special Roadway Excavation. When geotechnical conditions dictate, the Engineer may direct the Contractor to excavate material, which will not properly support the roadway, and replace it with other material. In those cases the additional excavation shall be paid as provided for under "Extra Work Items". The material used to replace the excavated material shall be in accordance with Item 130 "Borrow" and shall be paid for as provided under "Borrow" i.e. measured in place by the method of average end areas. The material shall be replaced in accordance with the Item 132 "Embankment".

110.4 Measurement and Payment. The quantity of excavation to be paid for shall be the number of cubic yards of material computed by theoretical cross-sections, obtained from the drawings and natural ground lines, including stripping, using the method of average end areas. Field cross-sections will not be performed after construction has begun.

Payment for excavation of ditch or swale is on a linear foot basis. Payment for this item includes hauling of spoil material as indicated in the bid proposal, strippings, stock pile of strippings, compaction to 95% standard proctor density and re-application of strippings. Different payment will be used for different cross sections of ditches (V-Bottom, varied bottom width).

After bidding, if the Contractor contests the estimated quantities for stripping and/or excavation, as shown on the bid sheet, he shall provide at no expense to Harris County, sufficient documentation in the form of recoverable cross-sections and supporting computations. This documentation shall be provided prior to proceeding with any stripping and/or excavation work. No adjustments to the excavation quantities will be allowed once stripping and/or excavation work has begun.

If the documentation provided by the Contractor, is deemed by Harris County to be insufficient, additional supporting information may be required, at no expense to Harris County.

If the documentation, provided by the Contractor, is deemed by Harris County to be correct and is representative of actual field conditions, then the derived quantities shall be the basis of payment for excavation.

The Contractor must submit all required documentation within 14 calendar days of the project start date, or within 14 days of horizontal and vertical control information being provided, whichever occurs last. Requests to evaluate the stripping and/or excavation quantities will not be considered after this time. Stripping material will not be utilized as borrow or embankment, within the right-of-way on the Road project.

All work performed as required by this Item and measured as provided above, will be paid for at the unit price bid for "Roadway Excavation", which price shall be full compensation for preparing roadside ditches, trimming of slopes, hauling and storage of excavated material for other uses, disposal of unsuitable or surplus materials (wastage), preparation and completion of subgrade, shoulders, roadway, any necessary hauling and the furnishing of all labor, tools, equipment and incidentals necessary to complete the work.

Regrading of existing roadside ditches outside the limits of roadway excavation shall be measured in its original condition along the centerline and the total length be computed, in Linear Feet and shall be full compensation for furnishing all labor, supervision, supplies, materials, permits, and equipment required to complete the work, including all items of excavation, disposal, haul, compaction, grading, and ditch dressing as specified, in the project documents.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 130 "Borrow"

Item 132 "Embankment"

Item 200 "Stripping"

Item 560 "Maintenance and Cleanup of the Project Site"

END OF ITEM 110

ITEM 120

EXCAVATION FOR CHANNELS AND OTHER DRAINAGE FACILITIES

NOTE: *This item is intended for use for constructing drainage facilities which will not be maintained by the Harris County Flood Control District. Facilities for Flood Control maintenance are governed by the applicable HCFCD standards.*

120.1 Description. This Item shall govern the required excavation for all channels, detention ponds, and other drainage facilities, channel changes and ditches as shown on the plans, the removal and proper stockpiling or disposal of all excavated materials; including strippings on the entire length of channel or drainage facility, in conformity with the required lines, grades and typical sections and in accordance with the specification requirements herein outlined. Stripping is unsuitable material. Excavation for roadways and roadside ditches are specifically excluded. Ditches shall include inlet and outlet ditches to structures, and all ditches outside the confines of the roadway slopes. This excludes constructing embankment for channels and ditches shall be as outlined under the Item 132 "Embankment".

120.2 Construction Methods. All suitable materials removed from the excavation shall be used, insofar as practicable in the formation of embankments as required by the Item 132 "Embankment". Excavated material shall neither be permanently nor temporarily placed on the channel top of bank, nor will temporary shelves be cut into the channel side slopes, without the approval of the Engineer. All channel excavation utilized as embankment shall be placed in accordance with Item 132 "Embankment".

Unsuitable and/or excess excavation shall become the property of the Contractor and shall be disposed of by the Contractor outside of the limits of the right-of-way. The Contractor shall be responsible for disposal of all excavated material not used for backfill or grading berm areas. The disposal site shall not be an environmentally sensitive area, "Water of the United States", wetland or floodway. It is the responsibility of the Contractor to contact the proper authorities to determine land use classification and to obtain any necessary permits. Refer to Section 120.3 regarding Disposal Permits. However, if the disposal site is defined in the plans, then the County shall be responsible for ensuring that the appropriate Department of the Army permit has been obtained for the activity.

Cut-off channel meanders shall not be backfilled unless so indicated on the plans.

Any temporary construction access that crosses a channel shall be constructed so as to allow a continuous flow at all times. The channel flow line shall not be blocked or raised at any temporary construction access. Temporary construction access across a channel shall require a permit. If a permit is not included in the contract, the Contractor is not entitled to construct such access without securing a required permit.

When the plans indicate the fill of a channel side slope, the earthen fill material shall be placed in layers not to exceed 8 inches and shall be benched or notched into existing slopes and compacted by suitable rolling equipment to 90 percent of standard proctor density, per ASTM D698 "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort of (12,400 ft-lbf/ft³)" at a moisture content between +/- three percent of optimum.

Any earthen fill material, whether from onsite sources or imported, shall be free from roots, trash, silt and objectionable debris. Soils classified by ASTM D2487 "Standard Practice for Classification of Soils for Engineering Purposes" as clayey sands (SC), sand clay mixtures, or inorganic clays (CL) with a plasticity index from 15 to 40 are approved as fill materials. Each layer shall be compacted to 90 percent of standard proctor density (ASTM D698), at a moisture content between +/- three percent of optimum. The channel side slopes, in fill areas, shall be cut to the finished dimensions after completion of the fill process. Any imported earthen fill material shall comply with Item 130 "Borrow".

At the location of pipeline crossings, the Contractor shall suspend machine excavation at a location five feet before reaching the pipeline right-of-way, until a company representative is present to identify pipe location and to further direct excavation operations. The notification to the pipeline company of the Contractor's operations and the request for their representative's attendance shall be the responsibility of the Contractor. The Contractor shall not be reimbursed directly for any work or expenditure as a result of intersecting any pipeline operation. Any contingent costs therefore shall be anticipated in the preparation of the bid and included as distributed items of cost in the price for channel excavation.

At locations where lateral ditches or swales enter the channel, the Contractor shall perform grading as may be required to maintain the lateral ditches or swales within the easement area as approved by the Engineer. The cost of all grading shall be considered incidental to the unit price bid and no extra payment will be made.

Prior to final inspection by the Engineer, the Contractor shall remove all sediment from the bottom of the channel and dispose of this material off site. The cost of sediment removal and grading shall be incidental to the unit price bid, and no extra payment will be made.

120.3 Disposal Permits. The Contractor shall provide copies of the disposal permits to the County and post all disposal location permits on the jobsite.

120.4 Measurement & Payment. The quantity of excavation for channels and other drainage facilities shall be paid for by the number of cubic yards of material computed by theoretical cross-sections, obtained from the drawings and natural ground lines using the average end area method. Field cross-sections will not be performed after construction has begun. Excavation in Storm Water Quality basins and created wetlands may be paid for per cubic yard or per acre as stipulated in the bid proposal and/or drawings.

After project award, if the Contractor feels there is an error in the estimated quantities for excavation, as shown on the bid sheet, the plan quantity may be protested as delineated in Item 110.4 "Contesting Earthwork Quantities".

All work performed as required by this Item and measured as provided above, will be paid for at the unit price bid for excavation for channels and other drainage facilities which price shall be full compensation for preparation, trimming of slopes, storage and hauling of excavated material for other uses, disposal of surplus materials (wastage), any necessary hauling and the furnishing of all labor, tools, equipment and incidentals necessary to complete the work, as shown on the drawings.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 110 "Roadway Excavation"

Item 130 "Borrow"

Item 132 "Embankment"

Item 200 "Stripping"

END OF ITEM 120

ITEM 130

BORROW

- 130.1 Description. This Item shall govern proper utilization of fill materials secured from offsite sources obtained by the Contractor and approved by the Engineer. Compaction of borrow shall conform to the density control method as outlined in the Item 132 "Embankment".

Borrow shall be used only when there is an insufficient quantity of suitable onsite material available as outlined by Item 132 "Embankment". Borrow shall be used only as authorized by the Engineer, and shall be supplied from approved sources only.

- 130.2 Materials. Borrow material used for embankment shall consist of soil having a plasticity index not less than 12, nor more than 20 when tested in accordance with ASTM D4318 "Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils" or as directed by the Engineer. The maximum liquid limit allowed is 45, unless otherwise approved by the Engineer. The Contractor is required to inform the Engineer of the location of the pit or pits from which the fill material is to be taken and shall provide samples of the material for approval by the Engineer. In the event the material is not acceptable, as determined by the Engineer, the Contractor shall find other pit locations. All fill material shall be free from organic matter and deleterious material.

The use of a blend of cohesive and granular soils to achieve the required plasticity index will not be permitted.

- 130.3 Construction Methods. All suitable material obtained onsite and/or from borrow sources shall be used in the formation of embankments as required by the Item 132 "Embankment", or shall otherwise be utilized as indicated on the plans or as directed, and the completed work shall conform to the established alignment, grades and cross-section.

The Engineer shall be notified sufficiently in advance of opening any approved borrow source to permit necessary testing, prior to the use of the material as borrow.

The borrow site shall not be located within a "Water of the United States" or environmentally sensitive area. It is the Contractor's responsibility to obtain any and all Federal, State or Local permits associated with operation of the borrow site; if it is not an approved commercial borrow site.

County Borrow Source.

During construction, the borrow source shall be kept drained, insofar as practicable, to permit final cross-sections to be taken when required.

The borrow source shall be left in a suitable condition, so as to provide proper drainage where practicable.

130.4 Measurement and Payment. Borrow is a plan quantity pay item that represents the excess embankment needed over the total excavated material from all onsite sources. These sources include, but may not be limited to:

- A. roadway excavation (Item 110),
- B. detention pond and/or channel excavation (Item 120),
- C. storm sewer excavation,
- D. and/or structural excavation (Item 400).

Roadway excavation and detention pond and/or channel excavation are calculated by cross sections using the average end area method, whereas storm sewer excavation and structural excavation are volumetrically calculated.

After project award, if the Contractor feels there is an error in the estimated quantities for excavation, as shown on the bid sheet, the plan quantity may be protested as delineated in Item 110.4 "Contesting Earthwork Quantities".

All work performed as required herein and measured as provided above, will be paid for at the unit price bid for "Borrow", which price shall be full compensation for furnishing all labor, for all materials, for all royalties and freight involved, for all hauling, delivery and spreading on the road and compacting complete and in place and for all tools, equipment and incidentals necessary to complete the work.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 110 "Roadway Excavation"

Item 120 "Excavation for Channels and Other Drainage Facilities"

Item 132 "Embankment"
Item 205 "Subgrade"
Item 400 "Structural Excavation and Backfill"

END OF ITEM 130

ITEM 132

EMBANKMENT

132.1 Description. This Item shall govern for the placement and compaction of all suitable materials obtained from excavation of roadway right-of-way (Item 110), channels, and other drainage facilities (Item 120), structural and all underground utility excavation (Item 02317), and borrow (Item 130), used in the construction of project fill and/or embankment.

132.2 Construction Methods. Prior to placing any embankment, all stripping and/or clearing and grubbing operations shall have been completed on the excavation sources and areas over which the embankment is to be placed. Stump holes or other small excavations in the limits of the embankments shall be backfilled with suitable material and thoroughly compacted by approved methods before commencing embankment construction. The surface of the ground, including plowed loosened ground or surface roughened by small washes shall be restored to approximately its original slope by blading or other methods and where indicated on the plans or required by the Engineer, the ground surface thus prepared shall be compacted in accordance with the Item 205 "Subgrade".

Unless otherwise indicated on the plans, the surface of the ground of all unpaved areas, which are to receive embankment, shall be loosened by scarifying or plowing to a depth of not less than 4 inches. The loosened material shall be recompacted with the new embankment as hereinafter specified, and shall not exceed 8 inches in total depth.

Where indicated on the plans or as directed by the Engineer, the surface of the hillside to receive embankment shall be loosened by scarifying or plowing to a depth of not less than 4 inches, or cut into steps, benched or notched before embankment materials are placed. The embankment shall then be placed in maximum 8 inch loose layers, beginning at the low side in part width layers and increasing the widths as the embankment is raised. The material which has been loosened shall be recompacted simultaneously with the embankment material placed at the same elevation.

Where embankments are to be placed adjacent to or over existing roadbeds, the roadbed slopes shall be plowed or scarified to a depth of not less than 4 inches and the embankment built up in successive layers, as hereinafter specified to the level of the old roadbed before its height is increased. The top of the old roadbed shall be scarified and recompacted with the next layer of the new embankment. The total depth of the scarified and added material shall not exceed the permissible depth of layer.

Trees, stumps, roots, vegetation or other unsuitable materials shall not be placed in the embankment.

Except as otherwise required by the plans, all embankment shall be constructed in layers approximately parallel to the finished grade of the roadbed. Embankments shall be constructed to the grade established by the Engineer, and completed embankments shall correspond to the general shape of the typical sections shown on the plans and each section of the embankment shall correspond to the detailed section or slopes established by the Engineer. After completion of the roadway, it shall be continuously maintained to its finished section and grade until the project is completed.

Except as otherwise specified, earth embankment shall be constructed in successive layers for the full width of the individual roadway cross-section and in such lengths as are best suited to the sprinkling and compaction methods utilized.

Prior to compaction, the layers shall not exceed 6 inches in depth where pneumatic tire rolling is to be used and shall not exceed 8 inches in depth for rolling with other types of rollers. Layers of embankment may be formed by utilizing equipment which will spread the material as it is dumped, or they may be formed by being spread by blading or other acceptable methods, from piles or windrows dumped from excavating or hauling equipment in such amounts that the material is evenly distributed.

Each layer of embankment shall be uniform as to material and moisture content before compaction. Where layers of unlike materials abut each other, the material shall be mixed so as to prevent abrupt changes in the soil. No material placed in the embankment by dumping in a pile or windrow shall be incorporated in a layer in that position, but all such piles or windrows shall be moved by blading or similar methods. Clods or lumps of material shall be broken and the embankment material mixed by blading, harrowing, discing, or similar methods to the end that a uniform material is secured in each layer. Water required for sprinkling to bring the material to the moisture content necessary for maximum compaction shall be evenly applied and it shall be the responsibility of the Contractor to secure a uniform moisture content throughout the layer by such methods as may be necessary. In order to facilitate uniform wetting of the embankment material, the Contractor may apply water at the material source if the sequence and methods used produce the required results. Such procedure shall be subject to the approval of the Engineer.

Each layer shall be compacted to a minimum of 95 percent of standard proctor density per ASTM D698, “Laboratory Compaction Characteristics of Soil Using Standard Effort of 12,400 ft-lbf/ft³ (600 kN-m/m³)” using a moisture content between optimum and 3 percent above optimum. Soils shall not be compacted at less than the optimum moisture content.

After each layer of embankment or select material is complete, tests as necessary will be made by the Engineer. If the material fails to meet the density specified, the course shall be reworked, as necessary, to obtain the specified compaction.

Should the subgrade, due to any reason or cause, lose the required stability, density or finish before the pavement is placed, it shall be recompacted and refinished at the sole expense of the Contractor. Excessive loss of moisture in the subgrade shall be prevented by sprinkling, sealing or covering with a subsequent layer of asphaltic or other approved material.

- 132.3 Quality Assurance. The Contractor is responsible for the control of the quality of materials incorporated into the construction and the quality of completed construction. The County will engage materials engineering services to provide quality assurance testing and inspection to assist the County Engineer in determining the acceptability of materials and completed construction. Quality assurance services provided by the County do not relieve the Contractor of his responsibility for quality control. The Engineer shall not have control of the means, methods, techniques, sequences, or procedures of construction elected by the Contractor.

The Testing Laboratory's representative will determine the moisture-density relationships in accordance with ASTM D698, on material secured from each type of material encountered.

The Testing Laboratory's representative will determine the in-place density in accordance with ASTM D6938, "Standard Test Method for In- Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)" or ASTM D1556, "Standard Test Methods for Density and Unit Weight of Soil in Place by Sand-Cone Method". The minimum level of testing will consist of at least 3 tests for each 1,000 feet per lane of roadway or 4,000 square feet of embankment, per lift.

- 132.4 Measurement and Payment. Embankment shall not be paid for directly, but shall be incidental to roadway excavation, excavation for channels and other drainage facilities, construction of underground utilities, including all sewers. This includes any transporting and stockpiling of material.

There are no line codes for this Item.

NOTE: This Item requires other Standard Specifications

Item 102 "Clearing and Grubbing"
Item 110 "Roadway Excavation"
Item 120 "Excavation for Channels and Other Drainage Facilities"
Item 130 "Borrow"
Item 200 "Stripping"
Item 205 "Subgrade"
Item 02317 "Excavation and Backfill for Utilities"

END OF ITEM 132

ITEM 160

TOPSOIL

- 160.1 Description. This Item shall govern furnishing and placing topsoil to the lines, grades and depth shown on the drawings or as directed by the Engineer. Topsoil is defined as the surface layer of material containing decaying vegetable matter and roots. It is not necessary to strip the section of topsoil containing fine, hairline roots, only soil containing moderate to severe root mat.
- 160.2 References.
- A. AASHTO T194 "Standard Method of Test for Determination of Organic Matter in Soils by Wet Combustion"
 - B. ASTM D422 "Standard Test Method for Particle-Size Analysis of Soils"
 - C. ASTM D1140 "Standard Test Methods for Determining the Amount of Material Finer than 75- μ m (No. 200) Sieve in Soils by Washing"
 - D. ASTM D2974 "Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils"
 - E. ASTM D4972 "Standard Test Method for pH of Soils"
- 160.3 Materials.
- A. Topsoil shall be:
 - 1. capable of sustaining native plant growth,
 - 2. easily cultivated,
 - 3. highly resistant to erosion,
 - 4. free from objectionable material including gravel, large roots, stumps, wood, brush, debris, hard clods, clay balls, hardpan, refuse or other deleterious materials, and
 - 5. of reasonably uniform quality.
 - B. If topsoil is required for the project, it shall be provided from an onsite source, or imported as directed by the Engineer.

C. Imported Topsoil shall conform to the following requirements:

TABLE 1

SPECIFICATION	UNIT	VALUE	APPLICABLE STANDARD
Soil Reaction	pH	5.5-8.5 ¹	ASTM D4972
Passing No. 4 Sieve	%	95-100	ASTM D422
Sand Size, 2.0-0.05 mm	%	10-70	ASTM D422
Silt Size, 0.05-0.005 mm	%	0-40	ASTM D1140
Clay Size, <0.005 mm	%	20-50	ASTM D1140
Easily Oxidizable Organic Matter	%	2.5-10 ²	ASTM D2974 AASHTO T194

1. Determine pH by Method A for an onsite source and Methods A and B for imported topsoil. If the onsite source topsoil does not satisfy the specified pH range, achieve the desired pH by amending the soil as recommended by the certified agronomist's report of soil sample analysis.
2. Soil testing company shall identify test method used if different from the specified. The Engineer must approve alternate test methods.

D. Topsoil shall have Liquid Limit <50 and Plasticity Index <20.

160.4 Topsoil Delivery, Storage and Handling. Deliver, stockpile and handle topsoil in such a way as to not contaminate the material with other soils or objectionable materials.

The stockpile or disposal site shall not be located within an environmentally sensitive area, floodway, wetland, or in "Waters of the United States". If the stockpile or disposal site must be located in wetland as defined in the plans, then the County shall be responsible for ensuring that the appropriate Department of the Army permit has been obtained for the activity.

160.5 Construction Methods.

A. Strip topsoil as specified on the plans or as directed by the Engineer from area to be excavated or filled and stockpiled for use on the final grades and ditch slopes. Install and maintain proper Storm Water Pollution Prevention Plan Best Management Practices

(SWPPP BMPs) to stockpiled topsoil at no additional cost to Harris County.

- B. Prior to placing topsoil, scarify or plow the subgrade to a minimum depth of 4 inches until it is loose and uncompacted to provide bonding of topsoil layer to subgrade. Remove vegetation and foreign inorganic material. Place topsoil on loosened material and roll lightly with appropriate lawn roller to consolidate topsoil.
- C. The Contractor shall place the topsoil to the lines and grades and to the depths shown on the drawings.
- D. Remove spilled topsoil from curbs, gutters, and paved areas and dispose of excess topsoil offsite.
- E. Place topsoil to promote drainage and compact with light roller. Water topsoil after placement until saturated for minimum specified depth. Fill in and recompact any areas of settlement.
- F. Do not place topsoil when it is excessively wet or dry.
- G. If the topsoil excavated from the site will be utilized for the construction of wetlands, then the Contractor shall store the material in piles less than 5 feet in height to ensure the survivability of the existing seed bank.
- H. Topsoil may be used as approved by the Engineer to meet the requirements of Item 132 "Embankment" for the top 4 inches of fill for unpaved areas of the project. When so utilized, it will be included as part of the embankment, volume and its placement will be incidental to the Item 110 "Roadway Excavation", as is the embankment itself. Compaction of topsoil shall comply with the compaction requirements of this Item, and not Item 132.

160.6 Submittals Required. Contractor shall submit certification from their supplier that their topsoil meets the material requirements of Section 160.3.

The Contractor is required to submit the location of the pit(s) and a sample from which the material is to be taken, for the Engineer's approval. The Contractor shall submit the vendor's technical description of the topsoil.

160.7 Quality Control. The Engineer may question the quality of material at any stage of work or location if changes in characteristics are apparent.

160.8 Measurement. When topsoil has to be imported from sources other than the job site, topsoil shall be measured per square yard of specified depth furnished, delivered and placed, in accordance with these Standard Specifications. Topsoil placed in accordance with Section 160.5 above is considered as Embankment.

160.9 Payment. Payment for imported topsoil when shown in the plans shall be made at the contract unit price per square yard of specified depth of topsoil, which price shall be full compensation for all labor, materials, equipment and incidentals necessary to furnish, haul and place the topsoil.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 132 "Embankment"

END OF ITEM 160

ITEM 162

SODDING FOR EROSION CONTROL AND STABILIZATION

162.1 Description. This Item shall govern for providing and planting Bermuda grass, St. Augustine grass, or other acceptable sod along or across such areas as are designated on the drawings and in accordance with the specification requirements herein outlined.

162.2 Materials. The sod shall consist of living, growing Bermuda grass, St. Augustine grass, or other acceptable sod, (ninety-five percent pure), secured from sources where the soil is fertile and has been fumigated. The sod shall have a healthy virile root system of dense, thickly matted roots throughout. The sod shall be cut from the field so that there is a minimum of 1/2 inch of soil on the roots of the sod, and so that no roots show on the bottom of the soil. Sod shall be dense, with the grass having been mowed to 1 inch height before lifting from field. Sod shall be in a vigorous condition, dark green in color, free of disease and harmful insects. The Contractor shall not use sod from areas where the grass is thinned out, nor where the grass roots have been dried out by exposure to the air and sun to such an extent as to damage its ability to grow when transplanted. The sod shall be free from obnoxious weeds or other grasses and shall not contain any matter deleterious to its growth or which might affect its subsistence or hardiness when transplanted. Unless the area has been closely pastured, it shall be closely mowed and raked to remove all weeds and long-standing stems.

Care shall be taken at all times to retain the native soil on the roots of the sod during the process of excavation, hauling and planting. Sod material shall be kept moist from the time it is dug, until planted. When so directed by the Engineer, the sod existing at the source shall be watered to the extent required, prior to excavating. Do not stack sod for more than 36 hours between the time of cutting and the time of installation. The Engineer reserves the right to reject any sod deemed unacceptable for installation.

All planting shall be done between the average date of the last freeze in the spring and six weeks prior to the average date for the first freeze in the fall, according to the U.S. Weather Bureau.

Fertilizer shall conform to the requirements of the Item 166 "Fertilizer" and shall be applied at the rate of 480 pounds per acre.

162.3 Construction Methods. Immediately after the finished grade has been approved, begin sodding operations to reduce excessive weed growth. If

the sod bed is dry, immediately prior to sod installation, dampen the surface with a fine mist of water.

Grass shall be turf sod, cut into 16 inch strip widths for those areas behind a curb. All other areas can receive various cut widths and lengths.

All areas to be sodded shall be raked to true lines, free from all unsightly variations, bumps, ridges or depressions. All sticks, stones, roots or other objectionable material which might interfere with the formation of a finely pulverized sod bed, shall be removed from the soil.

Lay sod so that adjacent strips butt tightly, with no spaces between strips. Lay sod on mounds and slopes, with strips parallel to contours. Stagger joints. Sodded areas shall be flush with adjoining seeded areas. All sod shall, of course, be laid green side up. Tamp and roll the sod thoroughly to make contact with the sod bed, or as directed by the Engineer.

Peg sod on slopes three-to-one or steeper with pegs driven through sod into soil, until pegs are flush with the turf. Space pegs 18 inches on center. Pegs to be 1 inch square, 6 inches long or, 6 inch lengths of lath.

Commercial fertilizer as outlined in the Item 166 "Fertilizer" shall be applied to the entire sodded area at the prescribed rates, immediately following laying the sod. Immediately after fertilizing, water the entire area until a saturated depth of 2 inches has been reached. If rain is imminent, then the application of fertilizer shall be postponed until weather conditions exist such that the potential for the runoff of fertilizer from the site is minimized.

Immediately after installation of the sod, remove sod clumps, soil, and any plant material from roadways and pavements. Edges along curbs and drives, walkways, etc., shall be carefully trimmed and maintained until accepted.

In areas where sod is dead, satisfactory growth may be accomplished with application of seeding or hydromulch seeding in lieu of replacing the dead sod, only as approved by the Engineer. Costs for labor, materials, tools and equipment for the application of seeding or hydromulch seeding over dead sod shall be incidental to this pay item.

162.4

Contractor's Maintenance & Guarantee Period. It shall be the responsibility of the Contractor to maintain all sodded areas until satisfactory growth has occurred as determined by the Engineer and for a period of 60 days after the successful completion of all punch list items. Maintenance shall consist of watering, weeding, repairing of all erosion, and resodding as necessary to establish a uniform growth of the specified

grass. A minimum of 95 percent of the area planted shall be covered with the specified grass with no bare or dead spots greater than 10 square feet.

The Contractor shall be responsible for 1 mowing per month between the months of April to October. The Contractor shall also be responsible for 1 mowing every 6 weeks between the months of November to March.

In addition, the Contractor shall water all sodded areas as often as necessary to establish satisfactory growth and to maintain its growth throughout the duration of the project; including in the 60 day period described above.

Contractor shall make as many repeat plantings as necessary to achieve a minimum of 95 percent of the area planted covered with the specified grass with no bare or dead spots greater than 10 square feet. Such replanting is to be performed within 14 calendar days of notification by the Engineer.

- 162.5 Submittal Required. The Contractor shall submit a statement from the supplier attesting that the sod meets the requirements stated herein.
- 162.6 Measurement. Work and acceptable material for Sodding for Erosion Control and Stabilization shall be measured by linear feet (with standard width of 16 inches behind curb), or by the square yard (for various widths), complete in place.
- 162.7 Payment. Work performed and material furnished under "Measurement" shall be paid for at the unit price bid for "Sodding for Erosion Control and Stabilization", which price shall be full compensation for furnishing materials, preparation of ground for planting, planting of sod, pegging of sod, raking, fertilizing, watering, sprinkling, maintenance, mowing, and for labor, tools, equipment and incidentals necessary to complete the work. Additional payment shall not be made for those areas that are replanted.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications.

Item 166 "Fertilizer"

Item 725 "General Source Controls (SWPPP)"

END OF ITEM 162

ITEM 164

SEEDING AND EROSION CONTROL BLANKET

164.1 Description. This Item shall govern for preparing the ground, sowing of seeds, applying a fertilizer, and stabilizing with a mulch, mat, or mesh consisting of straw, hay, wood, coir, paper, or other biodegradable fibers along and across such areas as are designated on the plans and in accordance with these Standard Specifications.

164.2 Material. Seed shall comply with the (Texas) Agriculture Code, Title 5, Subtitle A, Chapter 62 "Seed and Plant Certification", Sections 62.009, 62.010, 621.011 and the U. S. Department of Agriculture Rules and Regulations – Federal Seed Act. Seed bags shall have tags affixed for inspection in the field. Bags without tags will be rejected. Seed shall be tested and certified by a commercial or state laboratory not more than nine (9) months prior to the date of planting. Tags on seed bags shall show the name of the seed, locality and year of harvest, percentage purity, germination and dormant seed, Johnson grass content and noxious weed content. Seed shall be provided in clean, unopened and undamaged bags. Seed shall be provided with no objectionable material, such as sticks, stems and unthreshed seed heads, which will hinder proper distribution. Seed that is wet, moldy, starting to germinate or otherwise damaged, will not be accepted by Harris County.

Standard seed plan, planting dates, plant species and planting rates shall be as indicated in Table 1:

TABLE 1

<u>SEED PLAN</u>	<u>PLANTING DATES¹</u>	<u>SPECIES</u>	<u>PLANTING RATE PER ACRE</u>
<u>1</u>	<u>Oct. 1- March 31 (When soil temperatures fall below 75°F, or as directed)</u>	<u>Unhulled Bermuda Grass Tall Fescue & Durana Clover Crimson Clover</u>	<u>50 lbs. 25 lbs. 5 lbs. 5 lbs.</u>

<u>SEED PLAN</u>	<u>PLANTING DATES¹</u>	<u>SPECIES</u>	<u>PLANTING RATE PER ACRE</u>
<u>2</u>	<u>April 1-Sept. 30 (When soil temperatures rise above 65°F, or as directed)</u>	<u>Certified Bermuda Grass² or Common Bermuda Grass, minimum purity/germination of 95/85 Millet</u>	<u>50 lbs. or 50 lbs. PLS³ 10 lbs.</u>
<u>3</u>	<u>As directed</u>	<u>Certified Bermuda Grass² or Hulled Bermuda Grass minimum purity/germination 95/85 and Pensacola Bahia Grass Brown Top or Fox Tail Millet</u>	<u>50 lbs. or 50 lbs. PLS³ and 20 lbs. 20 lbs.</u>
<u>5</u>	<u>As directed</u>	<u>Annual Ryegrass & Fescue or Millet</u>	<u>25 lbs. each 25 lbs.</u>
<u>6</u>	<u>As directed</u>	<u>Improved Bermuda Grass Cultivars</u>	<u>50 lbs.</u>
<u>7</u>	<u>As directed</u>	<u>Legume or Grain</u>	<u>20 lbs.</u>

1. Planting dates are approximate; Harris County will determine which seed to use prior to start of seeding.
2. Certified Bermuda Grass must have a Blue Tag and tested by an accredited seed testing lab.
3. Seeding rate for "Pure Live Seed" (PLS) is used to determine the actual application rate of bulk material to apply.
 - a. Calculate PLS: PLS = (% germination x % purity)
0.95 x 0.85 = 0.807 (80.7%) PLS
 - b. Calculate quantity: Rate ÷ PLS = lbs. of seed needed for application
50 lbs. ÷ 0.807 = 61.95 lbs. of seed needed per acre

164.3 Fertilizer. Commercial fertilizer as outlined in the Item 166 "Fertilizer", shall be applied to the entire seeded area at the prescribed rates. The fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, conforming to the applicable State Fertilizer Laws and bearing the name and warranty of the producer.

164.4 Straw Mulch. Straw mulch shall be oat, wheat, or rice straw. Hay mulch shall be prairie grass, Bermuda grass, oat, wheat or rice stems or other hay as approved by the Engineer. Do not use straw containing Johnson

grass or other noxious weeds and foreign materials. The mulch shall be kept in a dry condition and shall not be molded or rotted.

- 164.5 Fiber Mat. Fiber mat shall consist of machine produced woven mat of wood, coir, straw, or a combination of various biodegradable fibers as approved by the Engineer, with consistent thickness throughout the blanket. The fiber mat shall have a mesh or netting for support. The mesh or netting shall be biodegradable or photo-degradable and have a high wet strength. The mat shall not contain any weed seeds. Use blanket with a weight from 0.7 pounds per square yard to 1.0 pound per square yard. The mat shall be free of defects, rips, holes, flaws, deterioration, mold, rot, or damage.

Material type, size, shape, and spacing of wire staples, or fasteners, shall be in accordance with the recommendations of the manufacturer of the fiber mat erosion control blanket.

- 164.6 Paper Mesh. Use paper mesh consisting of knitted construction of yarn with uniform openings interwoven with strips of biodegradable paper, furnished in rolls which have suitable protection for outdoor storage. Use paper mesh of weight from 0.2 pounds per square yard to approximately 0.5 pounds per square yard. The mesh shall be free of defects, rips, holes, flaws, deterioration, mold, rot, or damage.

Material type, size, shape, and spacing of wire staples, or fasteners, shall be in accordance with the recommendations of the manufacturer of the paper mesh erosion control blanket.

- 164.7 Construction Methods.

A. General

Fertilizing & Seeding. After areas to receive fertilizing and seeding have been completed to the lines, grades and sections shown on the plans, apply fertilizer at the prescribed rates as outlined in the Item 166 "Fertilizer". Thoroughly mix upper 3 inches of top soil with fertilizer until a uniform mixture of fertilizer and top soil is obtained. Sprinkle areas to be seeded with water, using fine spray to avoid washing or erosion of soil. Broadcast seed with sowing equipment at the rate specified above, using care to obtain uniform distribution. After broadcasting, lightly rake seeds into soil to a depth not to exceed 1/2 inch. Complete seeding by rolling with roller developing 15 to 25 pounds per inch of tread.

After applying seed and fertilizer, apply straw mulch, fiber mat, or paper mesh as described in the following sections. Keep seeded

areas moist for a period of 10 days immediately following placement and as necessary to meet Contractor's maintenance and guarantee period. When watering seeded areas, use fine spray to prevent erosion of seeds or soil. Reseed any areas damaged by erosion and as necessary to obtain a satisfactory growth as determined by the Engineer.

If rain is imminent, then seeding and fertilization shall be postponed until weather conditions exist such that the potential for the runoff of fertilizer from the site is minimized. If high wind conditions exist then the subsequent application of the straw mulch, fiber mat, or paper mesh erosion control blanket shall be postponed until weather conditions exist such that the blanket can be installed properly.

B. Straw Mulch Erosion Control Blanket

1. Fertilizing & Seeding. After ditch or slope has been completed to lines, grades and cross-sections shown on the plans, apply fertilizer and seed in accordance with the above. When seed and fertilizer are to be distributed as water slurry, mixture is to be applied within 30 minutes after all components are placed in the equipment.
2. Mulch Application. Immediately upon completion of planting of seed and fertilizing, spray straw mulch uniformly over the area at the rate of 1-1/2 to 2 tons of hay or 2-1/2 tons of straw per acre. Mulching machine shall inject tacking agent into straw uniformly as it leaves the equipment at the rate of 0.05 to 0.10 gallons of tacking agent per square yard of mulched area. When watering seeded areas, use fine spray to prevent erosion of seeds or soil. Reseed any areas damaged by erosion for any reason. The mulching operation shall immediately follow seeding and fertilizing as a continuous operation.

C. Fiber Mat or Paper Mesh Erosion Control Blanket

1. Fertilizing and seeding shall be in accordance with the above.
2. Fiber Mat or Paper Mesh Installation. Place fiber mat or paper mesh within 24 hours after seeding operations have been completed. Prior to placing, clear the area to be covered of all rocks or clods over 1-1/2 inches in diameter and all sticks or other foreign material which will prevent

close contact of the blanket with the soil. Area shall be smooth and free of ruts or other depressions.

If as a result of a rain, prepared seed bed becomes crusted or eroded, or if eroded places, ruts or depressions exist for any reason, rework soil until smooth and reseed such areas. After area has been properly prepared, lay fiber mat or paper mesh flat, smooth and loosely without stretching or crimping material. Lay mat according to manufacturer's recommendations, generally with the mesh or netting on the top side.

Apply materials with lengths running parallel to the flow of water, or as shown on the plans or as directed by the Engineer. When more than one width is required, butt or overlap edges as required by the manufacturer. In general, for overlaps, the top edge shall overlap the bottom edge to match the direction of the flow of water, not against it.

Hold the material in place by means of a wire staple driven into the soil at an angle to the surface. Staple material along each edge and in a grid pattern with a minimum of 3 feet on center each way. In ditches and on slopes, provide additional stapling as recommended by the manufacturer.

The placement of the fiber mat or paper mesh erosion control blanket shall immediately follow the preparation of the ground.

164.8 Contractor Maintenance & Guarantee Period. It shall be the responsibility of the Contractor to maintain all seeded and erosion control blanket areas until satisfactory growth has occurred as determined by the Engineer, and for a period of 60 days after the successful completion of all punch list items. Maintenance shall consist of watering and weeding, repair of all erosion and any reseeding as necessary to establish a uniform stand of the specified grasses. A minimum of 95 percent of the area seeded shall be covered with the specified grass with no bare or dead spots greater than 10 square feet.

The Contractor shall be responsible for 1 mowing per month between the months of April to October. The Contractor shall also be responsible for 1 mowing every 6 weeks between the months of November to March. In addition, the Contractor shall water all grassed areas as often as necessary to establish satisfactory growth and to maintain its growth throughout the duration of the project.

The Contractor shall make as many repeat seedings as necessary to achieve a minimum of 95 percent of the area planted covered with the specified grass with no bare or dead spots greater than 10 square feet. Such replanting is to be performed within 14 calendar days of notification by the Engineer.

- 164.9 Submittal Required. The Contractor shall submit copy of seed tag(s) and letter from the supplier attesting that the seed meets the requirements as stated herein. Certification shall include common name; botanical name, percent by weight of each plant species; year of harvest; percent purity, germination and dormant seed; percent noxious weed content; and date of certification.
- 164.10 Measurement & Payment. Measurement shall be by the acre or square yard of prepared area underlying the erosion control blanket. Payment for work under this Item to be made at the contract price for "Seeding and Erosion Control Blanket", with price to be full compensation for the materials, tools, equipment, and labor necessary for preparing the area (including fine grading and rolling), seeding, fertilizing, placing and securing the fiber mat, and watering. Additional payment shall not be made for those areas that are repaired or reseeded.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications.

Item 166 "Fertilizer"

Item 725 "General Source Controls (SWPPP)"

END OF ITEM 164

ITEM 165

HYDRO-MULCH SEEDING
(FOR EROSION CONTROL AND STABILIZATION)

165.1 Description. This Item shall govern for furnishing all plant, labor, materials, equipment, supplies, supervision and tools and performing all work necessary to provide top soil, seed, fertilize, water, maintain and cleanup of side slopes and finished grades, all in accordance with these Standard Specifications, for the purpose of temporary erosion control or final stabilization.

The hydro-mulch seeding operations, together with all necessary related work, shall conform to the requirements specified in this section. The area(s) to be hydro-mulch seeded shall be as shown on the construction drawings.

165.2 Materials. All seed must meet the requirements of the U.S. Department of Agriculture Rules & Regulations as set forth in the Federal Seed Act and the Texas Seed Law.

Standard type of seed, purity and germination requirements, rate of application and planting dates are as shown on Table 1:

TABLE 1

<u>PLANT TYPE</u>	<u>RATE OF APPLICATION IN POUNDS OF SEED PER ACRE</u>	<u>PLANTING DATE</u>
<u>Common Bermuda Grass (60% Unhulled and 40% Hulled by weight)</u>	<u>60</u>	Apr. 1 to <u>Sep.30</u>
<u>* "Foxtail Millet"</u>	<u>15</u>	Apr. 1 to <u>Sep.30</u>
<u>Common Bermuda Grass (60% Hulled and 40% Unhulled by weight)</u>	<u>50</u>	Oct. 1 to <u>Mar.31</u>
<u>* "Gulf" Annual Ryegrass</u>	<u>15</u>	Oct. 1 to <u>Mar.31</u>
<u>Crimson Clover & Inoculant</u>	<u>20</u>	Oct. 1 to <u>Mar.31</u>
<u>* "KY 31" Tall Fescue</u>	<u>15</u>	Oct. 1 to <u>Mar.31</u>

*Indicates MAXIMUM APPLICATION RATE ALLOWED

Table 1 shall be used except for special applications. For special applications, the seed mix, rate of application, and planting dates shall be as shown in the plans.

Commercial fertilizer as outlined in the Item 166 "Fertilizer", shall be applied to the entire seeded area at the prescribed rates. The fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, conforming to the applicable State Fertilizer Laws and bearing the name and warranty of the producer.

Mulch shall be virgin wood cellulose fiber made from whole wood chips. Within the fiber mulch material, at least 20 percent of the fibers will be 10.7 mm in length and 0.27 mm in diameter. Rate of application shall be 2000 pounds per acre. Soil stabilizers such as Terra Type III (or approved equal) shall be applied at a rate of 40 pounds per acre on side slopes and Terra Tack I (or approved equal) shall be applied at a rate of 40 pounds per acre on flatter portions. Alternatively, Ultra Bond 2002 (or approved equal) shall be applied at a rate of one gallon per square yard in three applications. First application shall be at a rate of 1/2 gallon per square yard followed by another application in about two weeks at a rate of 1/4 gallon per square yard. Third application shall follow in about two months at a rate of 1/4 gallon per square yard. The concentrate shall be diluted in 1:5 ratio with water or as recommended by the manufacturer.

Wood cellulose fiber mulch, for use in the grass seed and fertilizer, shall be processed in such a manner that it will not contain germination or growth inhibiting factors. It shall be dyed an appropriate color to allow visual metering of its application. The wood cellulose fibers shall have the property of becoming evenly dispersed and suspended when agitated in water. When sprayed uniformly on the surface of the soil, the fibers shall form a blotter-like ground cover which readily absorbs water and allows infiltration to the underlying soil. Weight specifications from suppliers for all applications shall refer only to the underlying soil. Weight specifications from suppliers, shall refer only to the air dry weight of the fiber. The mulch material shall be supplied in packages having a gross weight not in excess of 100 pounds and must be marked by the manufacturer to show the dry weight content. Suppliers shall be prepared to certify that laboratory and field testing of their product has been accomplished and that it meets all of the foregoing requirements.

Water shall be free from oil, acid, alkali, salt and other substances harmful to the growth of grass. The water source shall be subject to approval, prior to use.

165.3 Execution. Immediately after the finished grade has been approved, begin hydro-mulching operations to reduce erosion and excessive weed growth.

Hydraulic equipment used for the application of fertilizer, seed and slurry of prepared wood fiber mulch shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend and homogeneously mix a slurry containing up to 40 pounds of fiber plus a combined total of 70 pounds of fertilizer solids for each 100 gallons of water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles

which provide even distribution of the slurry on the area to be seeded. The slurry tank shall have a minimum capacity of 800 gallons and shall be mounted on a traveling unit, which may either be self-propelled or drawn with a separate unit which will place the slurry tank and spray nozzles within sufficient proximity to the areas to be seeded, so as to provide uniform distribution without waste. The Engineer may authorize equipment with a smaller tank capacity, provided the equipment has the necessary agitation system and sufficient pump capacity to spray the slurry in a uniform coat.

Care shall be taken that the slurry preparation take place on the site of the work. The slurry preparation should begin by adding water to the tank when the engine is at half throttle. When the water level has reached the height of the agitator shaft, good re-circulation shall be established and seed shall be added. Fertilizer shall then be added, followed by wood pulp mulch. The wood pulp mulch shall only be added to the mixture after the seed and when the tank is at least one-third filled with water. The engine throttle shall be opened to full speed when the tank is half filled with water. All the wood pulp mulch shall be added by the time the tank is two-thirds to three-fourths full. Spraying shall commence immediately when the tank is full. The operator shall spray the area with a uniform visible coat, by using the green color of the wood pulp as a guide.

- 165.4 Application. The contractor shall obtain approval of hydro-mulch area preparation from the Engineer prior to application. If rain is imminent, then the application of hydromulch seeding and fertilizer shall be postponed until weather conditions exist such that the potential for the runoff of the slurry and fertilizer from the site is minimized.

Operators of hydro-mulching equipment shall be thoroughly experienced in this type of application. Apply the specified slurry mix in a motion to form a uniform mat at the specified rate. Operators shall keep the hydro-mulch within the areas designated and keep from contact with other plant material. Immediately after application, thoroughly wash off any plant material, planting areas or paved areas not intended to receive slurry mix.

Keep all paved and planting areas clean during maintenance operations. Contractor shall keep hydro-mulching within the areas designated and keep from contact with other plant material.

If in the opinion of the Engineer, unplanted areas are noted after hydro-mulching, the contractor shall be required to seed the unplanted areas with the grasses that were to have been planted at no additional cost to Harris County.

- 165.5 Contractor's Maintenance & Guarantee Period. It shall be the responsibility of the contractor to maintain all hydromulch seeded areas until satisfactory growth has occurred as determined by the Engineer and for 60 days after the successful completion of all punch list items. Maintenance shall consist of watering, weeding, repairing of all erosion, and reseeded, as necessary to establish a uniform stand of the specified

grasses. A minimum of 95 percent of the area seeded shall be covered with the specified grass with no bare or dead spots greater than 10 square feet.

The Contractor shall be responsible for 1 mowing per month between the months of April to October. The Contractor shall also be responsible for 1 mowing every 6 weeks between the months of November to March. In addition, the Contractor shall water all grassed areas as often as necessary to establish satisfactory growth and to maintain its growth throughout the duration of the project; including the 60 day period described above.

The Contractor shall make as many repeat seedings as necessary to achieve a minimum of 95 percent of the area planted covered with the specified grass with no bare or dead spots greater than 10 square feet. Such replanting is to be performed within 14 calendar days of notification by the Engineer.

165.6 Submittal Required. The contractor shall submit copy of seed tag(s) and letter from the supplier attesting that the seed meets the requirements as stated herein. Certification shall include common name; botanical name, percent by weight of each plant species; year of harvest; percent purity, germination and dormant seed; percent noxious weed content; and date of certification. The Contractor shall certify on the application of the project.

165.7 Measurement. The unit of measurement for all work performed and materials furnished, as described herein, shall be by the acre or per station as indicated in the bid documents. Measurement shall be done upon completion of the work performed within the limits shown on the drawings and as described herein. The area measured for payment will be computed to the nearest 1/10 acre or station.

165.8 Payment. Payment for hydro-mulch seeding will be made at the contract unit price per acre or per station and includes top soil (when required), smoothing, mulch, seed fertilizer, watering, maintenance and clean-up. Additional payment shall not be made for those areas that are replanted.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications.

Item 166 "Fertilizer"
Item 725 "General Source Controls"

END OF ITEM 165

ITEM 166

FERTILIZER

- 166.1 Description. This Item shall govern for providing and distributing fertilizer over such areas as are designated for sodding for erosion control and stabilization, hydro-mulch seeding, or seeding and erosion control blanket and in accordance with these Standard Specifications.
- 166.2 Materials. All fertilizer used shall be delivered in bags or containers clearly labeled showing analysis. A pelleted or granulated fertilizer shall be used with an analysis of 10-10-5 (nitrogen – phosphoric acid – potash), unless otherwise approved by the Engineer. The figures in the analysis represent the nitrogen, phosphoric acid and potash nutrients respectively as determined by the methods of the Association of Official Agricultural Chemists. The sources of nitrogen in the fertilizer shall be roughly balanced between ammonical (quick release) and nitrate nitrogen (slow release). Fertilizer shall be readily water-soluble.
- With permission of the Engineer, fertilizer of a different analysis may be substituted. It shall be pelleted or granulated fertilizer with a lower concentration. The total amounts of nutrients furnished and applied per acre shall equal or exceed that specified for each nutrient.
- 166.3 Construction Methods. When fertilizer is included in the specifications, pelleted or granulated fertilizer shall be applied uniformly over the area specified to be fertilized and in the manner directed for the particular item of work. Fertilizer shall be dry and in good physical condition. Fertilizer that is powdered or caked will be rejected. Distribution of fertilizer for the particular item of work shall meet the approval of the Engineer.
- Unless otherwise indicated on the plans, fertilizer shall be applied uniformly at the average rate of 480 pounds per acre for the Item 162 "Sodding for Erosion Control and Stabilization", 400 pounds per acre for the Item 164 "Seeding and Erosion Control Blanket" and for the Item 165 "Hydro-Mulch Seeding for Erosion Control and Stabilization".
- 166.4 Measurement. Acceptable material for "Fertilizer" will be measured by the C-WT (100 lbs) as determined by approved scales or guaranteed weight of sacks shown by manufacturer.
- 166.5 Delivery, Storage and Handling. Deliver fertilizer in bags or containers clearly labeled with name and address of the manufacturer, weight and guaranteed analysis. Bulk fertilizer, if approved by the Engineer, must be accompanied by either an invoice or label showing the name and address of the manufacturer, guaranteed analysis, and appropriate means to accurately measure and record weight of fertilizer used.

Deliver fertilizer in clean, unopened and undamaged bags.

166.6 Payment. No separate payment shall be made for materials furnished or work performed under this Item. Include the cost of same in the contract price bid for work of which this is a component part.

For special applications in which fertilizer is not already a requirement of another bid item, payment shall be made by the acre of applied area. Application rate (pounds per acre) and analysis (nitrogen – phosphoric acid – potash) shall be as shown in the plans.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications.

Item 162 “Sodding for Erosion Control and Stabilization“

Item 164 “Seeding and Erosion Control Blanket”

Item 165 “Hydro-Mulch Seeding for Erosion Control and Stabilization”

Item 725 “General Source Controls”

END OF ITEM 166

ITEM 200
STRIPPING

- 200.1 Description. This Item shall govern stripping of existing topsoil to approximately 3 inches depth or as shown on the drawings and disposing of the stripped material off-site. Within the limits indicated, or in areas where existing grade is to be altered either by excavation or embankment, the Contractor shall strip existing topsoil to approximately 3 inches depth or as shown on the drawings and dispose of it at the Contractor's expense. Stripping shall include the removal and disposal of scrap iron, rubbish, logs, abandoned utilities, abandoned signs, and any and all other debris, if within the right-of-way or designated easements, whether above or below existing grade. Field cross-sections will no longer be obtained.
- 200.2 Construction Methods. The stripped material shall be removed as designated below regardless of the project area to be excavated or receive embankment. Strippings are unsuitable material and shall not be considered for use in the future construction. The strippings and any other unsatisfactory material shall be removed and disposed of outside the right-of-way, by the Contractor. No strippings shall be used in median or in areas from back-of-curb to R.O.W. *Proper Storm Water Pollution Prevention Best Management Practices shall be applied to stripped areas.*
- When disposing of strippings and waste, off site, the Contractor shall not place the material in an “*environmentally sensitive area, floodway or 'Water of the United States', including adjacent wetland*”, as defined in the Clean Water Act and the Rivers and Harbors Act, unless he has previously obtained the appropriate Department of the Army Permit authorizing the activity. If the stockpile or disposal site is defined in the plans, then the County shall be responsible for ensuring that the appropriate Department of the Army permit has been obtained for the activity.
- 200.3 Measurement & Payment. Stripping and any associated stockpiling, or disposal will not be paid for directly. Payment for stripping shall be incidental to excavation, borrow or embankment.

There are no line codes for this Item.

NOTE: This Item requires other Standard Specifications

Item 110 “Roadway Excavation”
Item 130 “Borrow”
Item 132 “Embankment”

END OF ITEM 200

ITEM 205

SUBGRADE

205.1 Description. This Item shall govern the proof rolling and compaction of the subgrade for pavements. When the road is to be surfaced or paved and after the earthwork has been substantially completed and after all storm sewer and drains have been laid, the subgrade shall be brought to the lines, grades and typical cross-section shown on the plans and in accordance with these Standard Specifications.

205.2 Construction Methods. After stripping the Contractor shall proof roll the subgrade, (i.e. verify that the subgrade is firm and able to support, without displacement, construction equipment), and correct any soft or yielding areas (by scarifying and aerating, replacing unsuitable material with borrow material, stabilization.....etc). Proof rolling equipment shall meet the requirements of Item 216 "Proof Rolling" of the Texas Department of Transportation's "Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges", Latest Edition. Whenever unsuitable natural material is encountered and cannot be handled by the excavation or embankment requirements, then the following requirements shall apply. The unsuitable material shall be excavated to a depth deemed sufficient by the Engineer and the excavated material shall be disposed of off the jobsite at the expense of the Contractor. The excavated area shall be filled to its original level with suitable material meeting the requirements of Item 130 "Borrow". This imported material shall be compacted to 95 percent of standard proctor density, (ASTM D698, "Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)))" using a moisture content ranging from optimum to plus 3 percent above optimum. Soils shall not be compacted at less than the optimum moisture content.

After all holes and depressions are filled with approved material, the subgrade shall be brought up to the lines and grades required and if it is not to be stabilized, it shall be compacted to 95 percent of standard proctor density, (ASTM D698), using a moisture content between optimum and 3 percent above optimum. The subgrade, without stabilization, shall be compacted to a depth of 9 inches.

After the roadbed has been prepared it shall be allowed to stand, or "cure", under traffic until, in the opinion of the Engineer, it is in a satisfactory condition to receive a surface course. During this curing period, the roadbed shall be maintained by the Contractor, at no additional cost to Harris County.

The subgrade shall be kept free from all ruts and weak spots. Any ruts and weak spots that develop under traffic shall be repaired with suitable material as they develop.

- 205.3 Special Subgrade Finish for Concrete Pavement, Constructed by Slip Form Paving Operation. After the subgrade has been prepared, as specified, and has been compacted as specified and immediately before the base or surfacing material is to be placed on the subgrade, it shall be tested as to crown and elevation by the use of a template, or other approved methods, furnished by the Contractor. In the lower edge of the template, there shall be inserted bolts, 6 inches apart and to such depth that the heads will just come to the true elevation of the subgrade, when the template is riding on the forms longitudinally. Testing the elevation of the subgrade shall be done by moving the template back and forth on the forms. If the subgrade, when tested, is found to be as much as one fourth of an inch high, additional excavation shall be made until the required depth is obtained and the excavated material shall be deposited on the shoulders. Unless otherwise provided in the specifications, those areas below the true elevation shall be filled with concrete, making it an integral part of the slab. All expenses for this extra concrete material shall be borne by the Contractor. Before placing the concrete, the subgrade shall be cleaned of all loose material and thoroughly sprinkled.
- 205.4 Quality Assurance. The Testing Laboratory's representative will determine the Moisture-Density Relationship in accordance with ASTM D698, on material secured from the roadway or borrow source, for each type of material encountered or used.
- The Testing Laboratory's representative will determine the in-place density in accordance with ASTM D6938, "Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods" or ASTM D1556, "Test Methods for Density and Unit Weight of Soil in Place by Sand-Cone Method". The minimum level of testing will consist of at least 3 tests per lift for each 1,000 feet per lane of roadway or 4,000 square feet (500 square yards of embankment).
- 205.5 Measurement and Payment. The work prescribed under this Item, shall not be paid for directly, but shall be considered as subsidiary work of the Item 110 "Roadway Excavation", Item 130 "Borrow", or Item 132 "Embankment".

There is no line code for this Item.

NOTE: This Item requires other Standard Specifications

Item 110 "Roadway Excavation"
Item 130 "Borrow"
Item 132, "Embankment"

END OF ITEM 205

ITEM 360

CONCRETE PAVEMENT

- 360.1 Description. This Item shall govern for a pavement of Portland cement concrete with reinforcement. The pavement shall be as shown on the drawings, and may or may not include monolithic curbs. The pavement includes driveways.

The pavement shall be constructed as herein specified on the prepared subgrade or other base course in conformity with the thickness and typical cross-sections shown on the drawings, and to the lines and grades established by the Engineer. All materials shall be provided from an approved Texas Department of Transportation (TxDOT) supplier and it shall be the responsibility of the Contractor to provide certification that such approval has been met. In addition, other tests or approvals may be required at the discretion of the Engineer.

- 360.2 Materials. Harris County's standard mix design shall contain minimum 5-1/2 sacks (94 pounds per sack) of cementitious material per cubic yard and achieve a minimum compressive strength of 3,000 psi at 28 days, with the addition of fly ash, as necessary.

High Early Strength Concrete shall contain 7 sacks of Portland cement per cubic yard and may be produced from either Type I, Type II, or Type III Portland cement with other chemical admixtures.

The use of fly ash is acceptable and when used, the mix design shall contain 5-1/2 sacks of cementitious material per cubic yard with a fly ash content of not more than 25 percent by weight, and will achieve a minimum compressive strength of 3,000 psi at 28 days. It is recommended that the percent of fly ash by weight be reduced to a maximum of 20 percent during cold weather concreting (average ambient temperature, over a 24 hour period after placement, less than 50°F). Fly ash shall be Class C or Class F, conforming to the requirements of ASTM C618 "Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete". Fly ash shall have a minimum combined Oxide content of 50 percent or 70 percent for Class C or Class F respectively. Do not use Class C fly ash in sulfate-resistant (Type II cement) concrete.

Concrete shall be composed of Portland cement, water, chemical admixtures and coarse and fine aggregates, as outlined below:

- A. Portland cement shall meet the requirements of ASTM C150 "Specification for Portland Cement". Unless otherwise permitted or required, cement shall be Type I, Type II, or Type III.
- B. Mixing water for concrete shall conform to the requirements of ASTM C94 "Specification for Ready-Mixed Concrete".

- C. Chemical admixtures shall conform to the following specifications:
1. Air-entraining admixtures shall conform to the requirements of ASTM C260 "Specification for Air-Entraining Admixtures for Concrete".
 2. Chemical admixtures shall conform to the requirements of ASTM C494 "Specification for Chemical Admixtures for Concrete".
- D. Aggregates shall conform to ASTM C33 "Standard Specifications for Concrete Aggregates".

Coarse aggregate shall consist of durable particles of gravel, crushed stone, or combinations thereof, free from frozen material or injurious amounts of salt, alkali, vegetable matter, or other objectionable material either free or as an adherent coating, and its quality shall be reasonably uniform throughout. It shall contain not more than 0.25 percent by weight of clay lumps and not more than 1.0 percent by weight of laminated and/or friable particles. When tested by ASTM C136 "Sieve Analysis of Fine and Coarse Aggregates" and C117 "Minerals Finer than 75 μ m (No. 200) Sieve in Mineral Aggregates by Washing", it shall meet the following grading requirements:

TABLE 1
COARSE AGGREGATE GRADATION

	% Retained by Wt.	
Retained on 1-3/4" sieve	0%	
Retained on 1-1/2" sieve	0%	5%
Retained on 3/4" sieve	30%	65%
Retained on 3/8" sieve	70%	90%
Retained on No. 4 sieve	95%	100%

The loss by decantation shall be a maximum of 1 percent

- E. Fine aggregate shall consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without mineral filler. It shall be free from frozen material, or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall contain not more than 0.5 percent, by weight, of clay lumps. When subjected to the color test for organic impurities, ASTM C40 "Standard Test Method for Organic Impurities in Fine Aggregates for Concrete", the fine aggregate shall not show a color darker than the standard.

Unless otherwise specified, fine aggregate shall meet the following grading requirements:

TABLE 2
FINE AGGREGATE GRADATION

Retained on 3/8" sieve	0%
Retained on No. 4 sieve	0% to 5%
Retained on No. 8 sieve	0% to 20%
Retained on No. 16 sieve	15% to 50%
Retained on No. 30 sieve	35% to 75%
Retained on No. 50 sieve	65% to 90%
Retained on No. 100 sieve	90% to 100%
Retained on No. 200 sieve	97% to 100%

Fine aggregate shall be subjected to ASTM D2419 "Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate". The sand equivalent shall be not less than 80.

Mineral filler shall consist of stone dust, clean crushed sand or other approved inert material.

Unless otherwise designated on the drawings, or herein, all bar reinforcement shall be deformed and shall conform to ASTM A615 "Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement", Grade 60, open hearth, basic oxygen or electric furnace new billet steel. The use of Grade 40 is permissible for bars that must be bent. The use of prefabricated deformed steel bar mats, conforming to ASTM A184 "Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement", is not permitted.

Boards for expansion joint filler shall be 3/4 inch finished thickness. The material for the boards shall consist of Class A redwood or composite material as approved by the Engineer. The joint filler shall meet the requirements of ASTM D545 "Standard Test Methods for Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types)" and ASTM D1751 "Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)." Joint sealant shall be Type II or III and shall meet the requirements of ASTM D6690 "Standard Specifications for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements." Joint sealant for expansion joints shall be installed 1/4 inch below the top of pavement elevation. Prefabricated expansion joints may be used with approval by the Engineer.

Load transmission devices shall consist of an 18 inch smooth dowel placed equidistance through the center of the expansion joint and a locking device to hold the dowel parallel to the pavement grade and parallel to the longitudinal direction of the pavement.

The dowels shall be 3/4 inch in diameter for a pavement thickness of 6 inches. The dowels shall be 1 inch in diameter for pavement thickness of 7 inch or 8 inches. The dowels shall be 1-1/4 inch in diameter for

pavement thickness of 9 inches or more. All dowels shall be smooth and may be sheared or saw cut to the desired length.

The locking device shall be steel plate type (flat or wing), or a synthetic type of sleeve with the locking device being an integral part of the sleeve. If a metal plate-locking device is used on the dowel, a plastic sleeve with a complete closed end must be placed over the dowel on one side of the expansion joint. The synthetic type of sleeve with locking device satisfies this requirement.

Tie bars are to be of the same diameter and spacing as the reinforcing steel being used in the pavement, and shall be 30 inches minimum in length. Type III - adhesives meeting the requirements of TxDOT Material Specification DMS-6100 "Epoxy and Adhesives" shall be used for installing drilled-in reinforcing steel and dowels, into the existing concrete pavements.

360.3 Storage of Materials. Cement shall be stored in well ventilated weathertight buildings, bins, or silos which shall exclude moisture and contaminants.

Aggregate stockpiles shall be arranged and used in such a manner as to avoid contamination, with other materials or with other sizes of like aggregates. To ensure that this condition is met, any test for determining conformance to requirements for cleanliness and grading shall be performed on samples secured in accordance with ASTM D75 "Practice for Sampling Aggregates". Frozen or partially frozen aggregates shall not be used. Unless otherwise authorized by the Engineer, all aggregate shall be stockpiled at least 24 hours prior to use, to reduce free moisture content.

Chemical admixtures shall be stored in such a manner as to avoid contamination, evaporation, or damage. For those used in the form of suspensions or non-stable solutions, agitating equipment shall be provided to assure thorough distribution of the ingredients. Liquid admixtures shall be protected from freezing and from temperature changes which would adversely affect their characteristics.

360.4 Proportioning of Concrete. Concrete for all parts of the work shall be of the specified quality, capable of being placed without excessive segregation and, when hardened, of developing all characteristics required by this Item and the contract documents.

The specified compressive strength of the concrete, for each portion of the structure, shall be as designated in the contract documents. Strength requirements shall be based on the 28 day and 7 day compressive strength, respectively.

360.5 Concrete Classification. Concrete shall be classified as shown by Table 3.

TABLE 3 – CONCRETE CLASSIFICATION

Class	Nominal Coarse Aggregate	Cement Sacks Per C.Y.	Minimum 28-day Compressive Strength(f'c) (psi)	Minimum 7-day Compressive Strength(f'c) (psi)	Water – Cement Ratio, by Weight	
					Non-Air Entr. Conc. Min. – Max	Air Entr. Conc. Min. – Max
A ₁	1-1/2"	7	4,000	2,800	0.42 - 0.48	0.38 - 0.40
*A ₂	3/4"	7	4,000	2,800	0.48 - 0.55	0.43 - 0.49
B ₁	1-1/2"	6	3,500	2,400	0.49 - 0.56	0.44 - 0.52
*B ₂	3/4"	6	3,500	2,400	0.56 - 0.64	0.50 - 0.58
C ₁	1-1/2"	5.5	3,000	2,100	0.53 - 0.61	0.48 - 0.56
*C ₂	3/4"	5.5	3,000	2,100	0.61 - 0.70	0.54 - 0.63
D ₁	1-1/2"	5	2,500	1,750	0.59 - 0.67	0.53 - 0.62
*D ₂	3/4"	5	2,500	1,750	0.67 - 0.77	0.60 - 0.69

*Other nominal maximum aggregate sizes will be allowed, based on the thickness of section or spacing of reinforcing bar, or other criteria, as approved by the Design Engineer.

360.6 Selection of Proportions. Proportions of materials for concrete shall be established to provide:

- A. Workability and consistency to permit concrete to be worked readily into forms and around reinforcement under conditions of placement to be employed without segregation or excessive bleeding.
- B. Strength requirements in accordance with Table 3.
- C. Resistance to special exposure as required by the Engineer and as specified in the contract documents or in Special Provisions.

Unless otherwise permitted, the concrete mix design shall be proportioned to provide a slump between 1 and 6 inches. A slump range of 1 to 3-1/2 inches shall be used for concrete laid with a slip form paver, while vibrated concrete shall have a slump range of 2-1/2 to 6 inches, when tested in accordance with ASTM C143 "Standard Test Method for Slump of Hydraulic Cement Concrete". A slump test will be made for each sample of concrete obtained, or when slumps appear to be outside specification requirements. The Engineer may reject any concrete shown to be outside of these requirements.

The allowable air content for moderate exposure is:

1-1/2" aggregate (No. 2)	2.5 to 4.5 percent
3/4" aggregate (No. 5)	3.5 to 5.0 percent

All concrete pavement shall have a minimum design compressive strength of 3,000 psi at 28 days. A minimum of 4 test cylinders shall be made for each 150 cubic yards, or portion thereof, placed each day. Samples shall be taken in accordance with ASTM C172 "Standard Practice for Sampling Freshly Mixed Concrete" and molded and cured in accordance with ASTM C31 "Standard Practice for Making and Curing Concrete Test Specimens in the Field".

All test specimens shall be prepared in accordance with ASTM C617 "Standard Practice for Capping Cylindrical Concrete Specimens" and tested in accordance with ASTM C39 "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens". Two specimens shall be tested at 7 days and two specimens shall be tested at 28 days. The acceptance test results shall be the average of the two specimens tested for each age interval. If one specimen in a test age indicates evidence of improper sampling, handling, molding or testing, it shall be discarded and the strength of the remaining specimen shall be considered the test result. Should both specimens in a test interval show any of the aforementioned defects, the Engineer may request that cores be taken in the affected area.

Additional test specimens may be required due to concrete placing conditions and due to use of high early strength concrete. No extra compensation shall be allowed for materials and work involved in fulfilling these requirements.

360.7 Equipment. All equipment necessary for the construction of concrete pavement shall be on the job and shall have been approved by the Engineer as to condition, before the Contractor will be permitted to begin construction operations on which the equipment is to be used.

A template or other approved method, for checking the contour of the subgrade shall be provided and operated by the Contractor. The template shall rest upon the side forms and shall be of such strength and rigidity that under a test made by changing the support to the center, it shall not show a deflection of more than 1/2 inch. It shall be provided with accurately adjustable rods projecting downward to the subgrade at 1 foot intervals and these rods shall be adjusted to the required cross-section of the bottom of the slab, when the template is resting upon the side forms.

Side forms shall be of metal of approved cross-section. The preferred depth of the form shall be equal to the required edge thickness of the pavement. Forms with depths greater or less than the required edge thickness of the pavement will be permitted, provided the difference between the form depth and the edge thickness is not greater than 1 inch, and further provided that forms of a depth, less than the pavement edge

are brought to the required edge thickness by securely attaching wood or metal strips, of approved section, to the bottom of the form, or by grouting under the form.

The length of form sections shall be not less than 10 feet and each section shall provide for staking in position with not less than 3 pins. Flexible or curved forms of wood or metal of proper radius shall be used for curves of 100 foot radius or less. Forms shall be of ample strength and shall be provided with adequate devices for secure setting so that when in-place they will withstand without visible springing or settlement, the impact and vibration of the finishing machine. The forms shall be free from warp, bends or kinks and shall be sufficiently true to provide a reasonable straight edge on the concrete and the top of each form section, when tested with a straight edge, shall conform to the requirements specified for the surface of the completed pavement. Sufficient forms shall be provided for satisfactory prosecution of the work.

A minimum of two hand vibrators is required at the jobsite when placing concrete. A hand vibrator shall be used around all load transfer devices and intersections where screeds or slip form pavers cannot be operated.

Pavement shall be finished by machine, except as hereinafter provided. Placement shall be the Contractor's responsibility and shall be based upon equipment sequences utilized in accordance with the recommendations and practices of ACI 304R "Guide for Measuring, Mixing, Transporting, and Placing Concrete", and with the approval of the Engineer.

The Contractor shall furnish and maintain at least two standard 10 foot steel or aluminum straight edges.

Where applicable, the Contractor shall furnish a sufficient number of bridges equipped to ride on the forms and span the pavement for finishing operations and for the installation and finishing of joints and center strips. All necessary finishing and edging tools shall be furnished as may be required to complete the pavement in accordance with the drawings.

- 360.8 Slip Form Paver. Slip form pavers are allowed by Harris County.
- 360.9 Subgrade and Forms. The subgrade shall be excavated as required, all unstable or otherwise objectionable material removed, and all holes, ruts, and depressions filled with approved material, as per Item 205 "Subgrade". Rolling and sprinkling shall be performed when, and to the extent directed, and the roadbed shall be completed to or above the drawings of the typical sections shown on plans and the lines and grades established by the Engineer. Material excavated in the preparation of the subgrade shall be utilized in the construction of adjacent shoulders and slopes, and any additional material required for the completion of the sections shall be secured from sources indicated on plans or designated by the Engineer. Drainage of the roadbed shall be maintained at all times.

The subgrade shall be finished to the exact section of the bottom of the pavement as shown on plans, and tested with the approved template operated and maintained by the Contractor. The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade until the pavement is placed, and shall be kept thoroughly wetted down sufficiently in advance of placing any pavement to insure its being in a firm and moist condition for at least 2 inches below the prepared surface. Sufficient subgrade shall always be prepared in advance to insure satisfactory prosecution of the work. No equipment or hauling shall be permitted on the prepared subgrade, except on special permission of the Engineer, which will be granted only in exceptional cases and only where a suitable protection in the form of two-ply timber mats or other approved material is provided.

The subgrade under the forms shall be firm and cut true to grade so that each form section when placed will be firmly in contact for its whole length and base width, and exactly at the established grade. Any subgrade under the forms below established grade shall be corrected, using suitable material, placed, sprinkled and rolled as directed. Forms shall be staked with at least 3 pins for each 10 foot section. A pin shall be placed at each side of every joint. Form sections shall be tightly joined and keyed to prevent relative displacement. Forms shall be cleaned and oiled each time they are used.

Forms shall be set for a sufficient distance in advance of the point where concrete is being placed to permit a finished and approved subgrade length of not less than 300 feet ahead of concrete placement, or as approved by the Engineer. Conformity of the grade and alignment of forms shall be checked immediately prior to placing concrete and all necessary corrections made by the Contractor. Where any form has been disturbed or any subgrade becomes unstable, the form shall be reset and rechecked. In exceptional cases, the Engineer may require suitable stakes driven to the grade of the bottom of the forms to afford additional support. Sufficient stability of forms to support the equipment operated thereon and to withstand its vibration without springing or settlement shall be required. If forms settle over 1/8 inch under finishing operation, paving operations shall be stopped and the forms shall be reset to line and grade.

Forms shall remain in place for not less than 8 hours after the concrete has been placed. They shall be carefully removed in such a manner that little or no damage will be done to the edge of the pavement. Any damage resulting from this operation shall be immediately repaired. After the forms have been removed, the ends of all joints shall be cleaned, and any honeycombed areas pointed up with an approved mortar.

Immediately after pointing is complete, the form trench shall be filled with earth from the shoulders in such manner as to shed water from rainfall or curing away from the edge of the pavement. On completion of the required curing, the subgrade or shoulders adjacent to the pavement shall be placed in condition to maintain drainage.

360.10 Reinforcing Steel and Joint Assemblies. All reinforcing steel, tie bars, load transmission units and splices used in accordance with plan provisions meeting the requirements of Item 440 "Reinforcing Steel", shall be accurately placed and secured in position in accordance with the details shown on drawings.

Reinforcing bars shall be secured on alternating intersections and splices. The tie bars shall be installed in required position by the method and device shown on drawings, or by approved method and device equivalent thereto. Bar coatings required by plans, and of material specified, shall be completed and the bars and coating shall be free of rust, dirt or other foreign matter at the time of installation in the concrete. Reinforcing bars shall be supported on bar chairs or other approved devices placed on maximum 36 inches center each way, and placed so that the reinforcing bar is located at the centerline of the concrete.

Where plans require an assembly of parts at pavement joints, the assembly shall be completed, placed at required location and elevation, and all parts rigidly secured in required position by the method and devices shown on plans, or by approved method and devices equivalent thereto. Dowel bars shall be accurately installed in joint assemblies in accordance with drawings, each parallel to the pavement, and shall be rigidly secured in required position by such means (as shown on plans, or approved equivalent thereto) that will prevent their displacement during placing and finishing of the concrete. The assembled units comprising the load transmission devices shall be accurately installed in joint assemblies in accordance with plans, each unit vertical with its length perpendicular to the centerline of the pavement, and all units shall be rigidly secured in required position by such means (as shown on drawings, or approved equivalent thereof) that will prevent their displacement during placing and finishing of the concrete. Leader boards, joint filler and other material used for forming joints shall be accurately notched to receive each load transmission unit. All load transmission units shall be free of rust and clean when installed in the concrete.

360.11 Concrete Placing. Except by specific written authorization of the Engineer, concrete shall not be placed when the ambient temperature is below 40°F and falling. Concrete may be placed when the ambient temperature is above 35°F and rising, the ambient temperature being taken in the shade and away from artificial heat.

The Contractor shall have available a sufficient supply of approved cotton mats, polyethylene sheeting or other approved covering materials to immediately protect concrete if the air temperature falls to 32°F, or below, before concrete has been in place for less than 4 hours. Such protection shall remain in place during the period the temperature continues below 32°F, or for a period of not more than 5 days. Neither salt nor other chemical admixtures shall be added to the concrete to prevent freezing. The Contractor shall be responsible for the quality and strength of concrete under cold weather conditions and any concrete damaged by freezing shall be removed and replaced at the Contractor's expense.

The temperature of the concrete shall at no time exceed 100°F.

When the concrete reaches a temperature of 85°F, retarders shall be introduced into the mixture and shall continue to be used until the concrete reaches a temperature of 95°F.

After 95°F and through 100°F, a plasticizer shall be introduced into the mixture. After 95°F, ice may be used to control temperature, in lieu of a plasticizer.

For concrete between temperatures of 85°F through 95°F, the slump shall be as specified in this Item. For concrete with temperatures greater than 95°F, slumps shall be as specified by the Engineer.

The amount of retarder or plasticizer, introduced into a mixture, shall be in accordance with the manufacturer's recommendations. See Section 360.2, Materials, for requirements of admixtures.

No concrete shall be used if the concrete has developed initial set, or which is not in place within 1-1/2 hours after the initial water has been added.

Pouring concrete during inclement weather, which would adversely affect the quality and/or finish of the concrete pavement does not relieve the Contractor from his responsibility to provide a pavement that complies with the Item.

360.12

Joints. All transverse and longitudinal joints in the pavement shall be of the type or the alternate type shown on the drawings, shall be constructed at required locations, on required alignment in the required relationship to tie bars and joint assemblies and in accordance with the details shown on the drawings.

Normally, the stoppage of the placement of concrete shall be scheduled to occur at proposed expansion joints, or at proposed longitudinal joints located between traffic lanes. If it becomes necessary to stop the placement of concrete at an unscheduled location due to unforeseen circumstances, the stoppage may occur at a proposed contraction joint, or at other locations with the approval of the Engineer. The following provisions shall govern for each type of joint at which the placing of concrete is stopped:

When the placing of concrete is stopped at any expansion joint, the complete jointed assembly shall be installed and rigidly secured in required position as shown on plans. A bulkhead of sufficient cross-sectional areas to prevent deflection, to receive the load transmission units or dowels, as the case may be, and shaped accurately to the cross-section of the pavement shall be provided and installed as a back-up for the joint filler and rigidly secured in required position to permit accurate finishing of the concrete up to the joint. After the concrete has been

finished to the joint, formation of the joint seal space and finishing of the joint shall be executed as specified herein and in accordance with plan requirements. The back-up bulkhead shall remain in place until immediately prior to the time when concrete placing is resumed, when it shall then carefully be removed in such manner that no element of the joint assembly will be disturbed. The exposed portions of the joint assembly shall be free of adherent concrete, dirt or other material at the time placing of concrete is resumed.

All contraction and longitudinal joints that are not at the edge or end of a pour shall be saw cut. Metal or fiber strips placed in the uncured concrete will not be permitted. Where sawed joints are permitted by the Engineer, they shall be sawed as soon as sawing can be accomplished, without damage to the pavement, and as directed by the Engineer. Once sawing has commenced, it shall be continued until completed. The saw cut shall be made with one pass of the concrete saw. Sawing must be accomplished even in rain or cold weather. All sawing must be completed within 24 hours of the concrete pavement placement. Should the sawing for any day's placement fail to be completed within 48 hours; the following concrete placement shall be limited to the amount that was sawed on time. The limitation shall continue until the sawing crew demonstrates it can handle a larger volume of sawing.

The sawed cut shall be a minimum of 1/4 inch width and have a depth of one-fourth the thickness of the pavement. After sawcutting, the joint shall be sealed with joint sealer, in accordance with the instructions supplied by the manufacturer of the joint sealant.

Unless otherwise specified, transverse sawed control joints shall be constructed at 20 foot intervals measured along the longitudinal axis of the roadway, or as directed by the Engineer.

When placing of concrete is stopped at a longitudinal joint, all applicable provisions of Section 360.7 shall apply in addition to the following requirements:

The face of the bulkhead at the joint shall be grooved or recessed as necessary to provide the required spaces for the top and bottom breaker strips as shown on plans. The bulkhead shall be either drilled or notched to receive the tie bars. Tie bars shall be secured in required position by use of adequate transverse bracing and vertical supports meeting the approval of the Engineer.

When placing of concrete is stopped at a contraction joint, all applicable provisions of Section 360.7 shall apply, in addition to the following requirements:

The face of the bulkhead adjoining the slab end shall be notched and grooved to fit the exposed half-screen of the joint assembly and shall be shaped to form the slab end at the center of joint as shown on plans. The half-width of joint seal space may be formed by a strip of required section placed and removed in accordance with drawing requirements for

construction of transverse contraction joints. The Contractor shall have available a bulkhead shaped to the section of the pavement, and of a section to form a key not less than 1 inch in depth and 2 inches in height at the center of depth of the pavement. This bulkhead must be drilled to permit the continuation of all longitudinal reinforcing steel through the construction joint, and shall be of sufficient section and strength to prevent deflection.

Concrete shall be placed and finished to this bulkhead. Any concrete remaining on the subgrade ahead shall be removed and disposed of as directed. When placing of concrete is resumed before the concrete has set to the extent that the concrete will stand on removal of the bulkhead, the new concrete shall be rodded, and the key in the first concrete must be carefully preserved. An edge created by a construction joint of this type shall have a joint seal space and shall be sealed as required for construction joints.

Transverse expansion joints shall be formed perpendicular to the centerline and surface of the pavement, and shall be constructed in accordance with the sequence of operations shown on drawings. After the transverse finishing machine and before the longitudinal finishing machine has passed over the joint, the Contractor shall test the joint filler for correctness of position and make any required adjustment in position of the filler, and shall install the joint seal space form in accordance with plans. After removal at the joint seal form as required by plans, the joint seal space above the joint filler shall be thoroughly cleaned and the concrete faces of the joint seal space shall be left true to line and section throughout the entire length of the joint. On completion of curing of the pavement, the joint sealing filler of the type specified shall be placed in accordance with drawings. The faces of the joint seal space shall be clean and surface dry at the time joint sealing filler is placed. On completion of the joint seal, the pavement adjacent to the joint shall be left free of joint sealing material.

- 360.13 Finishing. All finishing shall be in accordance with ACI 325.6R "Texturing Concrete Pavements".

The Engineer shall approve the straightedge. The surface shall not vary from the straightedge by more than 1/16 inch per foot from the nearest point of contact, and in no case shall the maximum ordinate from a ten foot straightedge to the pavement be greater than 1/8 inch. Any high spots causing a departure from the straightedge in excess of that specified shall be ground down by the Contractor to meet the surface test requirements, when required by the Engineer.

- 360.14 Curing. The Contractor shall prevent surface drying of the pavement before application of curing system by means that may include water fogging, use of wind screens or the use of evaporation retardants. He shall provide for protection of freshly laid concrete against pitting and washing from rain, by having on the job at the time and place of pouring,

sufficient canvas and/or waterproof covering material to protect all placed concrete.

- A. Liquid Membrane. Liquid membrane curing shall be used as per Item 526 "Membrane Curing".
- B. Additional Curing Methods. Other methods meeting the requirements of ACI 308R "Standard Practice for Curing Concrete" must be submitted by the Contractor in writing prior to concrete placement and approved by the Engineer.

360.15

Protection of Pavement and Opening to Traffic. The Contractor shall erect and maintain the barricades required by the plans, and such other barricades and approved devices as will exclude public traffic and traffic of his employees and agents from the newly placed pavement for the periods of time hereinafter prescribed. Portions of the roadway, or crossings of the roadbed required to be maintained open for use by traffic, shall not be obstructed by the above required barricades. Crossings of the pavement required by plans, or by construction sequence, during the period prior to opening to traffic as herein specified, shall be provided with an adequate and substantial bridge, approved by the Engineer.

Cracked pavement shall be cored by Harris County any time after the 28 day cure time is complete. The location of these cores shall be selected by the Engineer. Pavement that has developed full depth cracks (greater than $t/4$ inch depth, where t = thickness of pavement) may, at the County's option, be left in place and repaired by the epoxy injection method. Otherwise the cracked pavement shall be removed and replaced. There shall be no additional payment for repairs or replacement. Basis of removal for cracked pavement shall be determined by the engineer and the extent of this pavement removal shall be based on the crack pattern and number of cracks in each panel. If the cracks are wide spread (vertically or horizontally) or close to expansion joint or control joint, and over a large area of 12 foot wide panel, then entire panel shall be removed and replaced as determined by the Engineer.

Surface cracks $t/4$ inches and less in depth may be repaired by the epoxy injection method at no cost to the County.

Prior to epoxy injection, the Contractor shall submit to the County for approval, the injection method to be used. The Contractor shall furnish a minimum of 2 year warranty when utilizing the epoxy injection method.

New pavement sections shall be closed to all traffic, both PUBLIC and CONSTRUCTION, until the concrete has attained a compressive strength of 2700 psi. If the Contractor or the County desires to open the new pavement section to traffic early, an additional set of test cylinders must be requested for an early test. If the early test indicates that the minimum compressive strength requirement has been met, and if all other requirements of this Item have been met, the pavement section can be opened to traffic. If the Contractor requests the early test, the Contractor

will pay the cost. If the County requests the early test, the County will pay the cost. Such opening of a new pavement section, to PUBLIC or CONSTRUCTION traffic, shall in no manner relieve the Contractor from his responsibility of the work.

On those sections of pavement to be opened to PUBLIC traffic, the pavement shall be thoroughly cleaned, stable material shall be placed, graded, and compacted against the pavement edge or curb unless specified otherwise, joints shall be sealed and cured, and all required traffic control work shall be performed for the safety of the traffic.

The Engineer may require the opening of pavement to traffic prior to the minimum strength specified above under conditions of emergency, which in his opinion, require such action in the interest of the public. In no case shall the Engineer order opening of the pavement to traffic within less than 72 hours after the last concrete in the sections is placed unless an approved high early strength concrete was used. The Contractor shall remove any curing mats, place earth against the pavement edges, and perform other work involved in providing for the safety of traffic as required by the Engineer in ordering emergency opening. Orders for emergency opening of the pavement to traffic will be issued by the Engineer in writing.

360.16 Backfilling Behind Curbs and in Medians and Directional Islands. The Contractor is required to backfill behind all curbs and within medians and directional islands, after completion of the paving operation. The backfill material shall be on-site material having the prior approval of the Engineer. No separate payment shall be made for backfilling behind curbs and in medians and directional islands, but it shall be considered incidental to this Item.

360.17 Deficient Pavement Thickness. It is the intent of this Item that the pavement be constructed in strict conformity with the thickness and typical sections shown on plans. Where any pavement is found not so constructed, the following rules relative to adjustment of payment for acceptable pavement and to replacement of faulty pavement shall govern.

The Engineer will check the thickness in accordance with the dimensions shown on the plans. The Engineer will perform 1 thickness test consisting of 1 reading at approximately the center of each alternate lane every 500 feet or fraction thereof. Core where directed in accordance with ASTM C174 "Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores." Verify deficiencies of more than 0.2 inch from plan thickness and to determine the limits of deficiencies of more than 0.75 inch from plan thickness. Fill core holes using a concrete mixture and method approved by the Engineer.

Thickness Deficiencies Greater than 0.2 inch. When any depth test measured in accordance with ASTM C174, is deficient by more than 0.2 inch from the plan thickness take an additional coring at that location to verify the measurement.

If the core is deficient by more than 0.2 inch but not more than 0.75 inch from the plan thickness, take 2 additional cores from the unit (500 foot length) at intervals of at least 150 feet and at locations selected by the Engineer, and determine the thickness of the unit for payment purposes by averaging the thickness of the 3 cores. (See Table for "Deficient Pavement Thickness price Adjustment Factor").

Thickness Deficiencies Greater than 0.75 inch. If a core is deficient by more than 0.75 inch, take additional cores at 10 foot intervals in each direction parallel to the boundary of the deficient area. The Engineer will evaluate any area of pavement found deficient in thickness by more than 0.75 inch. As directed, the Contractor shall remove and replace the deficient areas with concrete pavement of thickness shown on the plans, without additional compensation.

Pavement Units for Payment Adjustment. Limits for applying a payment adjustment for deficient pavement thickness from 0.20 inch to not more than 0.75 inch are 500 feet of pavement in each lane. Lane width will be shown on typical sections and pavement design standards.

For greater than 0.75 inch deficient thickness, the limits for requiring removal will be defined by coring as determined by the Engineer. The remaining portion of the unit determined to be less than 0.75 inch deficient will be subject to the payment adjustment based on the average core thickness at each end of the 10 foot interval investigation as determined by the Engineer.

Shoulders will be measured for thickness unless otherwise shown on the plans. Shoulders 6 feet wide or wider will be considered as lanes. Shoulders less than 6 feet wide will be considered part of the adjacent lane.

Limits for applying payment adjustment for deficient pavement thickness for ramps, widenings, acceleration and deceleration lanes, and other miscellaneous areas are 500 feet in length. Areas less than 500 feet in length will be individually evaluated for payment adjustment based on the plan area.

Table for Deficient Pavement Thickness Price Adjustment Factor.

Deficient Pavement Thickness Deficiency in Thickness Determined by Cores in Inches	Price Adjustment Factor Proportional Part Contract Price Allowed
0.00 to 0.20	100 Percent
0.21 to 0.30	80 Percent
0.31 to 0.40	72 Percent
0.41 to 0.50	68 Percent
0.51 to 0.75	57 Percent
Over 0.75	Remove and Replace

Any area found deficient in thickness by more than 0.75 inch shall be removed and replaced, at the Contractor's entire expense, with concrete of the thickness shown on drawings.

No additional payment over the contract unit price will be made for any pavements of a thickness exceeding that required on drawings and planing of concrete pavement shall not be allowed.

360.18 Non-Conforming Concrete. Any concrete deemed non-conforming, which in the opinion of the Engineer is unsatisfactory, shall be removed and replaced at the expense of the Contractor.

360.19 Quality Assurance. The Testing Laboratory's representative will sample concrete delivered to the site in accordance with ASTM C172 and will mold four specimens for each 150 cubic yards. Each time a set of specimens is molded, the slump will be determined in accordance with ASTM C143 and the air content in accordance with ASTM C173 "Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method" or C231 "Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method". Concrete cores, if required, shall be tested in accordance with ASTM C174 (9 point procedure) and ASTM C39.

360.20 Measurement. Concrete pavement shall be measured by the square yard of the specified mix design and thickness of completed and accepted pavement. Dowels, when required, shall be measured by each, as provided in the bid schedule.

360.21 Payment. The work performed and the materials furnished as prescribed by this Item and measured as provided under "Measurement" shall be paid for at the unit price bid for "Concrete Pavement", or "Concrete Pavement, High Early Strength", as required, or the adjusted unit price for pavement of deficient thickness as provided under "Penalty for Deficient Pavement Thickness", which price shall be full compensation for shaping and fine grading the roadbed, including furnishing and applying all water required; for furnishing, loading and unloading, storing, handling all concrete ingredients, including all freight and royalty involved; for mixing, placing, finishing and curing all concrete; for furnishing all materials for and placing longitudinal, warping, expansion, sawed control and contraction joints, and load transmission units, and joint filler material in proper position; for coating steel bars where required by plans, for furnishing and placing all reinforcing steel; and for all manipulations, labor, equipment, appliances, tools, traffic provisions and incidentals necessary to complete the work.

Doweling into the existing concrete pavement shall be paid for at the unit price bid per each of the specified size, which price shall be full compensation for drilling holes in the existing concrete pavement, providing and installing dowels and epoxy grouting them where required by the plans.

There are line code(s), description(s) and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 205 "Subgrade"
Item 440 "Reinforcing Steel"
Item 526 "Membrane Curing"

END OF ITEM 360

ITEM 400

STRUCTURAL EXCAVATION AND BACKFILL

400.1 Description. This Item shall govern for all excavation required for the construction of all structures within the roadway limits, except pipe or box sewers for the disposal of all excavated material; and for backfilling around completed structures to the original ground level or as required by the plans. The work shall include all necessary pumping, bailing, sheeting, drainage, and the construction and removal of any required cofferdams. Unless otherwise provided, the work included herein shall provide for the removal of old structures or portions thereof (abutments, wingwalls, piers, etc.), trees and all other obstructions to the proposed construction.

Excavation will not be classified, but will be considered as "Structural Excavation", which will include the removal of all materials encountered regardless of their nature or the manner in which they are removed as well as any required backfill, and as approved by the Design Engineer.

400.2 Structural Excavation. Unless specified on the plans, or approved otherwise by the Engineer, structural excavation shall be designated as follows:

- A. Width and Length - From a vertical plane outside the structure equal to the thickness of the footing or slab.
- B. Depth - From bottom of footing or slab to the finished groundline or natural groundline, whichever is lower in elevation.
- C. When caissons are provided, excavation is not permitted outside the outer face of the caissons.

By definition, a cofferdam is a temporary or removable structure to keep surrounding earth, water, or both out of the excavation and may be earth, timber, steel, concrete or a combination thereof.

A caisson is a permanent part of the substructure which sinks gradually into place as material is excavated within the area protected by its sidewalls. It may be either open well type or a pneumatic type caisson.

400.3 Construction Methods. Excavation shall be done in accordance with the lines and grades indicated on the plans, or as established by the Engineer.

The final elevation to which a foundation is to be constructed shall be as shown on the plans or as raised or lowered by written order of the Engineer when such alterations are judged proper to satisfactorily comply with the design requirements for the structure. Should it be found necessary, in the judgment of the Engineer to increase or decrease the depth of footings from that shown on the plans, the necessary alterations in the details of the structure shall be accomplished as directed by the Engineer. Harris County shall have the right to substitute revised details resulting from a consideration of the changes in the design condition.

When a structure is to rest on an excavated surface, special care shall be taken not to disturb the bottom of the excavation, and the final removal of the foundation material to grade shall not be performed until just before the footing is to be placed.

Protect excavations from rainfall and surface water. If the supporting soil is exposed to adverse wet or dry conditions, excavate deeper and/or wider to sound material at no additional cost to Harris County. Prior to such activity, the Contractor shall notify the Engineer.

Excavated material required to be used for backfill may be deposited, by the Contractor, in storage piles at points convenient for rehandling of the material during the backfilling operations. The location of storage piles shall, however, be subject to the approval of the Engineer, who may require that the survey centerline of the structure and the transverse or hub line of any unit of the structure be kept free of any obstruction.

Excavated material required to be wasted shall be disposed of as directed by the Engineer, and the disposal shall be in such manner as not to obstruct a stream or otherwise impair the efficiency or appearance of the structure or other parts of the work.

400.4

Cofferdams and Caissons. The term cofferdam wherever used in this Item designates any temporary or removable structure which is constructed to hold the surrounding earth, water, or both out of the excavation, whether such structure is formed of earth, timber, steel, concrete, or a combination of these. It thus includes earthen dikes, timber cribs, any type of sheet piling, removable steel sheets and the like and all necessary bracing; and it shall also be understood to include the use of pumping wells or well points for the same purpose. The cost of cofferdams shall be included as an incidental cost to excavation.

The term caisson, wherever used in this Item, designates a permanent part of the substructure, so constructed as to sink gradually into place as material is excavated within the area protected by its sidewalls. Such

caisson may be of either the open-well or pneumatic type and quantities for same will always be included as bid items separate from excavation.

In addition to interior dredging, the lowering of caissons may be facilitated by the following methods:

- A. Addition of weight by increasing the thickness of caissons, where such increase is permitted by the type of design, shall be requested by the Contractor prior to beginning the work. Increased quantities due to this change shall be at the Contractor's expense.
- B. By the addition of removable loads to the caisson.
- C. The use of water or air jets placed around the caisson.
- D. Steel shell caissons may be driven with a drop or air hammer if the Contractor, at his own expense, provides a suitable driving ring. The driving ring shall be of sufficient strength and the manner of driving shall be regulated to preclude damage to the caisson.

When no provisions for caissons is shown on the plans, it shall be the intent of this Item to require that a suitable cofferdam be provided for all excavations where such cofferdam may be necessary to control water conditions or to preclude sliding and caving of the walls of the excavation. Where no ground or surface water is encountered, the cofferdam needs to be sufficient only to protect the workmen and to avoid cave-ins or slides extending beyond the excavation limits.

The Contractor shall submit, to the Engineer, upon request, drawings showing his proposed method of cofferdam construction and other details left open to this choice, or not fully shown on the plans. All shoring designs must meet the requirements of OSHA Standard 1926.650.

The type and clearance of the cofferdam, insofar as such details affect the character of the finished work, will be subject to the approval of the Engineer, but other details of design will be left to the choice of the Contractor, who will be responsible for the successful completion of the work. The interior dimensions shall be such as to provide sufficient clearance for the construction and removal of any required forms and the inspection of their exteriors and to permit pumping outside of the forms.

In general, sheet piling cofferdams shall extend well below the bottom of the footings and shall be well braced and as water-tight as practicable.

When foundation pilings are to be driven inside a caisson or cofferdam and when it is judged impractical to dewater the caisson or cofferdam

before placing a concrete seal, the excavation may be extended below the footing grade to a depth sufficient to allow for swell of the material during pile driving operations. After the pilings have been driven, all foundation material that has risen to a level above the footing grade shall be removed. It is the intention of this provision to establish a construction tolerance to be applied when a foundation is being constructed under water. Where it is possible to dewater the caisson or cofferdam before a seal is placed, it is considered practicable to remove the foundation material to the exact footing grades after foundation pilings are driven. Backfilling in a foundation to compensate for excavation which has been extended below grade, will not be permitted. Such areas below grade shall be filled with concrete at the time the seals or base courses are placed, and the concrete quantities involved shall be at the Contractor's expense. All caisson and cofferdam designs must meet the requirements of OSHA Standard 1926.650.

Caissons or cofferdams which tilt or move laterally during the process of sinking shall be righted or enlarged, as necessary, at the sole expense of the Contractor.

Unless otherwise provided, cofferdams shall be removed by the Contractor after the completion of the substructure. The removal shall be affected in such a manner as not to disturb or mar the structure. In lieu of the entire removal of the cofferdams, the Engineer may require the Contractor to remove any portion of them or to leave them entirely in place.

400.5 Pumping or Bailing. Pumping or bailing from the interior of any foundation enclosure shall be done in such a manner as to preclude the possibility of the movement of water through or alongside any concrete being placed. No pumping or bailing will be permitted during the time of the placing of concrete or for a period of at least 24 hours thereafter, unless it is done from a suitable sump separated from the concrete work by a water-tight wall. Pumping or bailing to dewater a sealed cofferdam or caisson shall not be started until the seal has set for at least 36 hours.

400.6 Backfilling. All backfills shall be constructed in layers approximately parallel to the finished grade. After completion of the backfill, it shall be continuously maintained to its finished grade, until the project is accepted.

Backfill for retaining walls, headwalls, bridge abutments, and other special structures, shall be as shown on the plans.

Each layer of backfill shall be uniform as to material, density and moisture content before beginning compaction. Water required to bring the material

to the moisture content necessary for the required compaction shall be the responsibility of the Contractor.

Unless otherwise indicated, backfill compacted mechanically shall be in loose lifts not exceeding 8 inches. Backfill shall be clean bank sand, unless otherwise directed by the Engineer, free from clay and clay lumps, shale, loam, organic matter, salts and other deleterious materials and having a plasticity index less than 3. Backfill shall be compacted to 95 percent of Standard Proctor Density (ASTM D698 "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))") using a moisture content between optimum and 3 percent above optimum.

Do not place backfill against walls for a minimum of 7 days after structure has been in place. Place backfill against walls of partially completed structure only after approval of the Engineer. Backfill around abutments and piers shall be deposited on both sides to approximately the same elevation at the same time.

Care shall be taken to prevent any wedging action or backfill against the structure and the slopes bounding the excavation shall be stepped or serrated to prevent such wedge action.

No backfilling shall be done except in the presence of the Engineer, or his authorized representative.

400.7 Quality Assurance. The Testing Laboratory's representative will determine the moisture density relationship for each material proposed for use as backfill, in accordance with ASTM D698. In place density will be determined in accordance with ASTM D6938 "Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)" or ASTM D1556 "Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method", and with each type of construction.

For walls and trenches, determine the in place density at minimum for each 100 foot of wall or trench, for each lift of fill placed.

For building pads and parking areas, determine the in place density for each 4,000 square feet for each lift of fill placed.

400.8 Measurement and Payment. Will not be paid for directly, but will be considered subsidiary to the bid for structures requiring excavation and/or backfilling.

There are no line code(s), description(s), and unit(s) for this Item.

END OF ITEM 400

ITEM 420

CONCRETE STRUCTURES

420.1 Description. This Item shall govern for the construction of culverts, retaining walls, abutments, bents, piers, girders, slabs and all other structures involving the use of concrete.

All concrete structures shall be constructed in accordance with the design requirements and the details shown on the plans; in conformity with the pertinent provisions of the items contracted for and the incidental items referred to; and in conformity with the requirements herein set forth.

420.2 General Requirements. Before starting work, the Contractor shall inform the Engineer fully as to the methods of construction he proposes to follow and as to the amount and character of equipment he proposes to use; the adequacy of which shall be subject to the approval of the Engineer. Concurrence on the part of the Engineer in any proposed construction methods and approval of equipment, shall not relieve the Contractor of the responsibility for the safety or correctness of his/her methods or the adequacy of his/her equipment or from carrying out the work in full accordance with his/her contract.

420.3 Materials. All concrete shall conform to Item 421 "Structural Concrete" or as indicated on the plans. For multi-component structures, the class of concrete for each portion of the structure, shall be as designated in the contract documents.

Preformed expansion joint materials shall meet the requirements of ASTM D994 "Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)" or ASTM D1751 "Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)", as well as the Item 438 "Preformed Joint Seal".

Poured joints shall be asphalt that is homogeneous, shall be free from water and shall not foam when heated to 392° F. It shall conform to the following requirements:

Flash point (open cup), not less than	200°C (392°F)
Softening point (ring and ball method)	65°C to 110°C (149°F to 230°F)

Penetration at 0°C (32°F), 200 gms., 60 sec., not less than	10
Penetration at 25°C (77°F), 100 gms., 5 sec.,	30 to 50
Penetration at 46°C (115°F), 50 gms., 5 sec., not more than	110
Loss on heating at 163°C (325°F), 50 gms., 5 hrs., not more than	1.0%
Penetration at 25°C (77°F), 100 gms., 5 sec., of residue after heating at 163°C (325°F), as compared with penetration of asphalt before heating, not less than	60.0%
Ductility at 25°C (77°F), not less than	3.0 cm
Proportion of bitumen soluble in carbon tetrachloride, not less than	99.0%
Total bitumen (soluble in carbon disulphide), not less than	99.0%

All other materials such as reinforcing steel and structural steel shall conform to the requirements of the pertinent specifications.

420.4

General Construction Requirements. Before constructing forms and falsework for concrete superstructure spans over 20 feet in length; form and falsework plans shall be submitted to the Engineer for review and approval. Similar plans shall be submitted for other units of the structure if requested by the Engineer. The plans shall be prepared on standard sheets 22 inches x 34 inches overall size and shall be sufficiently complete to show all essential details of the proposed forms, falsework, and bracing for same. In general, not over six sets of such plans will be required.

Concurrence on the part of the Engineer in any proposed construction methods, approval of equipment, or approval of form and falsework plans shall not be considered as relieving the Contractor of the responsibility for the safety or correctness of his/her methods and adequacy of his/her equipment, or from carrying out the work in full accordance with the contract.

Unless otherwise provided, the following requirements shall govern for the time sequence in which construction operations may be carried on and for the opening of completed structures to traffic.

Steel I-beams or forms and falsework for superstructures shall not be erected on concrete substructures until the concrete in the substructures has cured at least 4 curing days. Concrete for concrete slab or girder spans or concrete slabs on steel I-beam spans shall not be placed until the substructure has cured at least 7 curing days.

Steel trusses or plate girders to be erected from the ground on approved falsework may be erected when the substructure has cured 4 curing days, but the falsework shall not be removed until the substructure has cured at least 7 curing days. Erection by means of a traveling crane on the span will not be permitted until the substructure has cured at least 7 curing days.

Forms for walls or columns shall not be erected on concrete footings until the concrete in the footing has cured at least 2 curing days. Concrete may be placed in the wall or column as soon as the forms and reinforcing steel placement is approved.

The use of completed portions of a structure as the site for mixing operations or for storage of materials will not be permitted until the particular portion of the structure has aged at least ten curing days.

A curing day shall be as defined in the Section 420.24 "Removal of Forms and Falsework". In continued cold weather the construction operations may be authorized at the end of a period of calendar days equal to twice the number of curing days specified above.

For bridges and direct traffic culverts, construction traffic and traveling public permitted in accordance with the following:

- A. Authorization for light construction traffic not to exceed a three-quarter ton truck may be given after last slab of concrete has been in place at least 14 days.
- B. Authorization for normal construction traffic, when necessary, and to traveling public may be given after last slab of concrete has been in place 30 days.

Forms or screed supports for bridges may be attached to I-beams or girders by welding.

420.5 Foundations. Excavation for foundations shall be made in accordance with the requirements of pertinent specifications.

Caissons shall be constructed of the materials and to the dimensions and details shown on the plans. Forms for concrete caissons may be of wood

or metal meeting the specified requirements. The operation of sinking will be permitted to proceed immediately after form removal.

Where necessary, falsework shall be provided to support the caisson during the construction and lowering period. Such falsework shall be of the strength required to support the caisson in combination with the forces of wind, water currents and drift.

Concrete foundation seals, if required, shall be of the thickness shown on the plans. The seals shall be Class D Concrete and shall be placed in accordance with the requirements herein for concrete placed in water. The completed seal shall not be higher or lower than the plan grade or the grade established by the Engineer, by more than 1/16 times the least inside caisson, cofferdam, or dredge well dimension at such grade.

The seal shall be allowed to set for at least 36 hours before the caisson or cofferdam is dewatered. After dewatering, the top of seal shall be cleaned off, all or other soft material readily loosened with a pick shall be removed, and all high spots which exceed the above limitation shall be cut off and removed.

Foundation piling shall be cut off square at the elevation shown on plans. A tolerance of not more than 2 inches above or below established cut-off grade will be permitted.

420.6 Drains. Weep hole drains shall be installed in abutments and retaining walls, and roadway drains or scuppers shall be installed in the roadway slabs in accordance with the details shown on the plans.

420.7 Expansion Joints and Devices. Expansion joints and devices to provide for expansion and contraction shall be constructed where and as indicated on the plans.

Unless otherwise provided on the plans, the bridge seat under the expansion ends of concrete slab spans and slab and girder spans shall be given a steel trowel finish, and the surfaces of substructure and spans and girders shall be separated by layers of roofing felt or a combination of roofing felt and sheet metal. Before installation, the contact areas of such roofing felt or sheet metal shall be coated with graphite grease. Layers of roofing felt or sheet metal shall be carefully placed so that concrete or mortar will not be worked around or under the material.

All joints constructed, to be left open or filled with poured joint material, shall be constructed using forms adaptable to loosening or early removal. In order to avoid jamming such forms by the expansion action of the spans and the consequent likelihood of injury to the adjacent concrete,

these forms shall be removed or loosened as soon as practicable after the concrete has attained its final set. A provision for loosening the forms to permit free expansion of the span without the necessity for full removal is preferred.

Armored joints shall be carefully constructed in order to avoid defective anchorage of the steel and to avoid porous or honeycombed concrete adjacent to same.

When premolded joint material is to be used in vertical joints of roadway and sidewalk slabs, the tops of such joints shall be adequately sealed with asphalt of the quality specified for poured joint materials. To accomplish this sealing, the top 2 inch depth of the joint shall be constructed open or the premolded material shall be plowed out and the space filled with liquid asphalt.

Premolded material, if specified, shall be used in expansion or contraction joints in abutment walls, wing walls and retaining walls. Metal flashing strips for the prevention of water seepage through wall joints shall be provided and installed in accordance with the plan provisions.

Premolded materials, wherever used, shall be anchored to the concrete on one side of the joint by means of copper wire not lighter than No. 12 B. & S. gauge. Such anchorage shall be sufficient to preclude the tendency of the material to fall out of the joint.

Careful workmanship shall be exercised in the construction of all joints to insure that the concrete sections are completely separated by an open joint or by the joint materials and to insure that the joints will be true to the outline indicated. Immediately after the removal of forms and again where necessary after surface finishing, all projecting concrete shall be removed along the exposed edges of premolded materials in order to secure full effectiveness of the expansion joint.

Where roofing felt or premolded material is specified for horizontal joints, the material shall, if practicable, extend 2 inches beyond the form for the top member. The projecting portions shall be subsequently trimmed to the face of the member after the forms are removed.

420.8 Construction Joints. The joint formed by placing plastic concrete in direct contact with concrete that has attained its initial set shall be deemed a construction joint. When concrete in a structure or a portion of a structure is specified to be placed monolithic, the term monolithic shall be interpreted to mean that the manner and sequence of concrete placing shall be such that construction joints will not be created.

Construction joints shall be of the type, location and spacing shown on the plans. Additional joints shall not be provided, without written authorization from the Engineer. Any additional construction joints shall have details equivalent to those shown on the plans for joints in similar locations.

Unless otherwise provided, construction joints shall be square and normal to the forms. Bulkheads shall be provided in the forms for all joints except horizontal joints.

The top surface of a concrete placement which terminates at a horizontal construction joint shall have the surface cement film removed and shall be thoroughly roughened as soon as practicable after the concrete has attained initial set. The surface at bulkheads shall be roughened as soon as the bulkhead forms are removed.

Before joining plastic concrete to concrete that has already set, the surface of the concrete in place shall be thoroughly cleaned up of all loose materials, , dirt or foreign matter; shall be washed and scrubbed clean with stiff brooms and thoroughly drenched with water until saturated, and shall be kept wet until the plastic concrete has been placed. Immediately prior to the placing of additional concrete, all forms shall be drawn tight against the concrete in place, and the surface of the concrete in place shall be flushed with a coating of grout mixed in the proportions of one part of cement to two parts of sand.

If shown on the plans, construction joints shall be provided with concrete keyways, reinforcing steel dowels, and/or metal flashing strips. The method of forming keys in keyed joints shall be such as to permit the easy removal of forms without chipping, breaking, or damaging the concrete in any manner.

420.9 Falsework. All falsework shall be designed and constructed so that no excessive settlement or deformation will occur, and so that the necessary rigidity will be provided. Details of falsework construction shall be subject to review and approval by the Engineer in accordance with the provisions of Section 420.4 "General Construction Requirements".

For calculating the loads on falsework, a weight of 150 pounds per cubic foot shall be assumed for concrete, and a live load allowance of 50 pounds per square foot of horizontal surface of the form work shall be included. The maximum stresses shall not exceed 125 percent of the allowable stresses used for the design of the structure.

All timber used in falsework centering shall be sound, in good condition, and free from defects which will impair its strength.

Steel members shall be of adequate strength and of such shape as to be suitable for the purpose intended.

Timber piling may be of any species of wood which will withstand driving satisfactorily and which will adequately support the superimposed load.

Where sills or timber grillages are used to support falsework columns, unless founded on, shale or other hard materials, shall be placed in excavated pits and backfilled to prevent the softening of the supporting material by drip from the forms or by rains that may occur during the construction process. Sills or grillages shall be of ample size to support the superimposed load without settlement.

Falsework which cannot be founded on a satisfactory spread footing shall be supported on piling which shall be driven to a bearing capacity sufficient to support the superimposed load without settlement. The safe bearing capacity of piling shall be determined by the formula specified elsewhere.

In general, each falsework bent shall be capped transversely at the proper elevation by a cap of adequate size. If desired by the Contractor, however, a short cap section forming a T-head may be substituted at the top of each pile or column in order to permit the removal of portions of the forms without disturbing the falsework. Caps shall be securely fastened to each pile or column in the bent and shall be set at the proper elevation to produce, in conjunction with the use of approved hardwood wedges or jacks, permanent camber indicated on the plans or specified, plus a construction camber covering allowance for deformation of the forms and falsework. The use of wedges to compensate for incorrectly cut bearing surfaces will not be permitted. Each falsework bent shall be securely braced to adjacent bents by bracing material of ample size to provide the stiffness required. The bracing shall be securely spiked or bolted to each pile or column it may cross.

420.10 Forms. Forms shall be built mortar-tight and of material sufficient in strength to prevent bulging between supports and shall be set and maintained to the lines designated until the concrete is sufficiently hardened to permit form removal. During the elapsed time between the building of the forms and the placing of the concrete, the forms shall be maintained in a manner to eliminate warping and shrinking. All details of form construction shall be subject to the approval of the Engineer, and permission to place concrete will not be given until all of such work is complete to his/her satisfaction.

Forms shall be designed for the pressure exerted by a liquid weighing 150 pounds per cubic foot. The rate of placing the concrete shall be taken into

consideration in determining the depth of the equivalent liquid. An additional live load of 50 pounds per square foot shall be allowed on horizontal surfaces. The maximum stresses shall not exceed 125 percent of the allowable stresses used for the design of the structures.

If, at any stage of the work, the forms show signs of bulging or sagging, that portion of the concrete causing such condition shall be immediately removed, if necessary, and the forms shall be reset and securely braced against further movement.

Lumber for forms shall be properly seasoned and of good quality. It shall be free from loose or unsound knots, knot holes, twists, shakes, decay, and other imperfections which would affect its strength or impair the finished surface of the concrete. The lumber used for facing or sheathing shall be finished on at least one side and two edges and shall be sized to uniform thickness.

The use of nominal 2 inch lumber, as a minimum thickness, will be required for forms for the bottoms of all superstructure girders except that in case of special forming of girders, as for curved-bottom girders where facing boards are transverse to beam, the Engineer may permit the use of 1 inch lumber. Nominal 1 inch thickness lumber will be permitted for general use on other portions of the structure if backed by a sufficient number of studs and wales.

Timber forms for exposed concrete surfaces which are required to be surface finished in accordance with these Standard Specifications shall be face lined with an approved type of form lining material such as masonite or plywood. If desired by the Contractor, facing for such surfaces may be constructed of 3/4 inch thick plywood backed by adequate studs and wales, and in this case form lining will not be required.

Forms or form lumber to be re-used shall be maintained clean and in good condition as to accuracy, shape, strength, rigidity, tightness, and smoothness of surface. Any lumber which is split, warped, bulged, marred, or has defects that may produced work inferior to that resulting from using new material, shall not be re-used.

Studs shall not be less than 2 inches by 4 inches nominal section and shall be spaced center to center not more than 20 times the actual thickness of the facing lumber. Wherever practicable, studs shall be capped at the top with a plate of not less than 2 inches by 6 inches nominal size, carefully selected as to straightness. All joints in plates shall be scabbed at least 4 feet each way to provide continuity.

Wales shall be spaced at such intervals as to hold forms securely to the designated lines. All wales shall be scabbed at least 4 feet on each side of joints to provide continuity. A row of wales shall be placed within 6 inches of the bottom of each placement.

Forms shall be rigidly braced to prevent movement while placing the concrete.

All face form material shall be fastened to all studs and shall have true horizontal and vertical joints. Facing material on horizontal and other surfaces shall be placed with parallel and square joints.

Molding specified for chamfer strips or other uses shall be made of redwood, cypress or pine materials of such grade that will not split when nailed and which can be maintained to a true line without warping. The molding shall be mill cut and dressed on all faces. Unless otherwise provided, forms shall be filleted at all sharp corners and edges with triangular chamfer strips. The strips shall be 3/4 inch measured on the sides.

Forms for railings shall be constructed to standards equivalent to first class mill work. All moldings, panel work, and bevel strips shall be straight and true with neatly mitered joints and of such design that the finished work shall be true, sharp and clean cut.

All forms shall be so constructed as to permit removal without damage to the concrete. Particular and special care must be exercised in framing forms for copings, offsets, and railing so that there will be no damage to or marring of the concrete when the forms are removed. If desired by the Contractor, the forms may be given a slight draft to permit ease of removal.

Metal form ties of an approved type shall be used to hold forms in place. Such ties shall be of a type especially designed for use in connection with concrete work, and they shall have provision to permit ease of removal of the metal as hereinafter specified. The use of wire form ties will not be permitted except for minor or special form areas where the use of rigid type metal ties would be impracticable.

All metal appliances used inside of forms to hold them in correct alignment shall be removed to a depth of at least 1/2 inch from the surface of the concrete and shall be so constructed that the metal may be removed without undue injury to the surface by chipping or spalling. Such devices, when removed, shall leave a smooth opening in the concrete surface. Burning off of rods, bolts, or ties will not be permitted.

Metal ties shall be held in place by devices attached to wales. Each device shall be capable of developing the strength of the tie.

Pipe spreaders will not be permitted.

Metal and wooden spreaders which are separate from the forms shall be entirely removed as the concrete is being placed.

Where wire ties are used, all wires, upon removal of the forms, shall be cut back at least 1/2 inch from the face of the concrete with a sharp chisel or nippers.

All cavities produced by the removal of metal ties shall be carefully cleaned and completely filled with re-tempered sand cement mortar mixed in proportion of one to three, and the concrete shall be left smooth and even.

Whenever practicable, forms shall be erected complete before the reinforcement is placed.

For narrow walls and other locations where access to the bottom of the forms is not readily attainable otherwise, adequate clean-out openings shall be provided.

At the time of placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust, and other extraneous matter.

The facing of all forms shall be treated with oil before concrete is placed. In hot weather, both sides of face forms may be required to be treated with oil to prevent warping and to secure tight joints. The oil must be applied before the reinforcement is placed. The oil used for this purpose shall be a light clear oil which will not discolor or otherwise injuriously affect the concrete surface.

In general, all forms shall be thoroughly wetted before the concrete is placed therein.

The foregoing specifications for forms, regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, re-use, oiling and wetting shall apply with equal force to all forms, except that metal forms will not require lining unless noted on the plans.

The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without

injury to the concrete. Metal forms which do not present a smooth surface or line up properly shall not be used. Special care shall be exercised to keep metal free from rust, grease, or other foreign material such as will tend to discolor the concrete.

420.11 Placing Reinforcement. Reinforcement in concrete structures shall be carefully and accurately placed and rigidly supported as provided in the Item 440 "Reinforcing Steel".

420.12 Placing Concrete, General. The Contractor shall give the Engineer sufficient advance notice before starting to place concrete in any unit of the structure to permit the inspection of forms, the reinforcing steel placement, and preparations for casting. Unless authorized by the Engineer, no concrete shall be placed in any structure until prior to the completion of the formwork and the placement of the reinforcement. No concrete shall be placed before the completion of all adjacent pile driving or other operations which might prove detrimental to the concrete.

Whenever it is necessary to continue the mixing, placing, and finishing of concrete after the daylight hours, the site of the work shall be brilliantly lighted so that all operations are plainly visible. In general, however, concrete placing shall be so regulated as to permit finishing operations to be completed in the daylight hours.

The Engineer reserves the right to order postponement of the placing operations when, in his/her opinion, impending weather conditions may result in rainfall or low temperatures which will impair the quality of the finished work. In case rainfall should occur after placing operations are started, the Contractor shall provide ample covering to protect the work. In case of drop in temperature, the provisions set forth in the Section 420.13 "Placing Concrete in Cold Weather" shall be applied.

The sequence of placing concrete shall be as provided on the plans or in the specifications. The operation of depositing and compacting the concrete shall be conducted so as to form a compact, dense, impervious mass of uniform texture which shall show smooth faces on all surfaces. The placing shall be so regulated that the pressures caused by the plastic concrete shall not exceed the loads used in the design of forms.

The method and manner of placing shall be such as to avoid the possibility of segregation or separation of the aggregate or the displacement of the reinforcement. Concrete shall not have a free fall of more than 3 feet except in the case of thin walls such as culvert walls.

Spattering on forms or reinforcement bars shall be prevented if the concrete so spattered will dry or harden before being incorporated in the

mass. Any hardened concrete splatter ahead of the plastic concrete shall be removed.

Each part of the forms shall be filled by depositing concrete directly as near its final position as possible. The coarse aggregate shall be worked back from the face and the concrete forced under and around the reinforcement bars without displacing them. Depositing large quantities at one point in the forms and running or working it along the forms will not be allowed.

After the concrete has taken initial set, the forms shall not be jarred or any strain placed on projecting reinforcement.

Chutes, troughs, conveyors or pipes used as aids in placing concrete shall be arranged and used so that the ingredients of the concrete will not be separated. When steep slopes are necessary, the chutes shall be equipped with baffle boards or be made in short lengths that reverse the direction of movement. Open troughs and chutes shall extend, if necessary, down inside the forms or through holes left in the forms, or the ends of such chutes shall terminate in vertical downspouts. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by a thorough flushing with water before and after each placement. Water used for flushing shall be discharged clear of the concrete in place. The use of chutes in excess of 35 feet total length for conveying concrete will not be permitted except by specific authorization from the Engineer.

Where the Contractor's operations involve the placing of concrete from above, that is, directly into an excavated area or through the completed forms, particularly in the case of abutments, piers, columns, retaining walls, and deep girders, and excepting thin walls such as culvert walls less than 12 inches, all concrete so placed shall be deposited through a vertical sheet metal or other approved pipe not less than 6 inches nor more than 10 inches in diameter. The pipe shall be made in sections so that the outlet may be adjusted to proper heights during placing operations.

Concrete shall be placed in continuous horizontal layers approximately 12 inches in thickness. Not more than one hour shall elapse between the placing of successive layers of concrete in any portion of the structure included in a continuous placement. The Contractor shall avoid unauthorized construction joints by placing required portions of abutments, pier walls or superstructures in one continuous operation. Laitance or foreign matter of any kind shall not be permitted to accumulate inside the forms. Openings in forms necessary for removal of shall be provided.

All concrete shall be well compacted and the mortar flushed to the surface of the forms by continuous working with concrete spading implements or mechanical vibrators of an approved type. Vibrators of the type which operate by attachment to forms or reinforcement will not be permitted. The vibrators shall be applied to the concrete immediately after deposit and shall be moved throughout the mass, thoroughly working the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms until it has been reduced to a plastic mass. The mechanical vibrator shall not be operated so that it will penetrate or disturb layers placed previously which have become partially set or hardened. The vibration shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures but shall not be done to an extent that will cause segregation. Vibration shall be supplemented by hand spading if necessary to insure the flushing of mortar to the surface of all forms.

Holes for anchor bolts in piers, abutments, bents, or pedestals may be drilled or may be formed by the insertion of oiled wooden plugs or metal sleeves in the plastic concrete. The plugs or sleeves shall be withdrawn after the concrete has set. When the holes are formed, they shall be of such diameter to permit horizontal adjustment of the bolts. The bolts shall be carefully set in mortar. In lieu of the above methods of placing, anchor bolts may be set to exact locations in the concrete when it is placed.

The placing of concrete for floor slabs of I-beam spans, girder spans, or truss spans preferably shall be done from a mixing plant located off the structure. If the mixer plant is to be located on the structure, it shall not be placed on a section of the roadway slab which has not aged for at least 10 curing days. Carting or wheeling concrete batches on a completed concrete floor slab will not be permitted until the slab has aged at least 4 curing days. If carts are used, the carts shall be wheeled on timber planking so that the loads and impact will be distributed over the slab. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

Stockpiling of concrete aggregate or cement on bridge floors will be permitted only when authorized by the Engineer, and, when permitted, the stock piles shall be uniformly distributed and shall be limited to not over 2 feet maximum depth. The storing of reinforcing or structural steel on completed roadway slabs shall generally be avoided, and, when permitted, such storage shall be limited to quantities and distribution that will not induce excessive stresses.

420.13 Placing Concrete In Cold Weather. No concrete shall be placed when the atmospheric temperature is at or below 40°F (taken in the shade away

from artificial heat) unless permission to do so is given in writing by the Engineer. When such permission is given or in cases where the temperature drops below 40°F after the concreting operations have been started, the Contractor shall furnish sufficient canvas and framework or other type of housing to enclose and protect the structure in such way that the air around the forms and fresh concrete can be kept at a temperature not less than 50°F for a period of five days after the concrete is placed. Sufficient heating apparatus such as stoves, or steam equipment and fuel to furnish all required heat shall be supplied. The treatment of mixing water and aggregates used in mixing concrete shall be as specified in "Concrete". The placing of concrete in cold weather shall conform to the requirements of ACI 306.

It is understood that the Contractor is responsible for the protection of concrete placed under any and all weather conditions. Permission given by the Engineer to place concrete during freezing weather will in no way relieve the Contractor of the responsibility for satisfactory results. Should concrete placed under such conditions prove unsatisfactory, it shall be removed and replaced at the expense of the Contractor.

420.14 Placing Concrete in Hot Weather. Unless otherwise directed by the Engineer, when the temperature of the air is above 85°F, an approved retarding agent will be required in all concrete or direct traffic culverts. An approved retarding agent will be required in all cased drilled shafts, regardless of temperature.

420.15 Placing Concrete In Water. Concrete shall be deposited in water only when specified on the plans or with the permission of the Engineer. The forms, cofferdams, or caissons shall be sufficiently tight to prevent any water current passing through the space in which the concrete is being deposited. Pumping will not be permitted while the concrete is being placed, nor until it has set for at least 36 hours.

The concrete shall be carefully placed in a compact mass by means of a tremie, closed bottom-dump bucket or other approved method that does not permit the concrete to fall through the water. The concrete shall not be disturbed after being deposited. Depositing shall be regulated to maintain an approximately horizontal surface at all times.

When a tremie is used, it shall consist of a tube having a diameter of not more than 10 inches, constructed in sections having watertight connections. The means of supporting the tremie shall permit the movement of the discharge end over the entire top surface of the work and shall permit the tremie to be rapidly lowered when necessary to choke off or retard the flow. The number of times it is necessary to shift the

location of the tremie, for any continuous placement of concrete, shall be held to a minimum.

During the placing of concrete, the tremie tube shall be kept full to the bottom of the hopper. When a batch is dumped into the hopper, the tremie shall be slightly raised, but not out of the concrete at the bottom, until the batch discharges to the level of the bottom of the hopper. The flow shall then be stopped by lowering the tremie. The placing operations shall be continuous until the work is complete.

When concrete is placed by means of a bottom-dump bucket, the bucket shall have a capacity of not less than 1/2 cubic yard. The bucket shall be lowered gradually and carefully until it rests upon the concrete already placed. It shall then be raised, very slowly, during the upward travel, the intent being to maintain, as nearly as possible, still water at the point of discharge and to avoid agitating the mixture.

420.16 Placing Concrete in Slab Spans. Concrete in slab spans shall be placed in longitudinal strips. Placing preferably shall be started at a point in the center of the span adjacent to one curb and the longitudinal strip thus started shall be completed by depositing concrete uniformly in both directions toward the ends of the span. The width of longitudinal strips shall be such that the concrete in any strip will not take its initial set before the adjacent strip is placed. The concrete in the curbs shall be placed in proper sequence to be monolithic with the adjacent longitudinal strip of the slab.

The forms for the bottom surface of the slab shall be maintained true to the required vertical alignment during the placing of concrete in the span. For convenience in checking the vertical alignment, an approved system of "tell-tales" shall be installed and maintained by the Contractor. The "tell-tales" shall be attached to the form and shall provide a convenient means of matchmarking with reference to points set on stakes or other suitable reference points set independent of the forms and falsework for the span being placed.

On completion of the filling of the curb forms, the curbs shall be brought to the correct camber and alignment, and then they shall be struck off and float finished.

As soon as concrete is placed in a longitudinal section of the slab of a width necessary to permit finishing operations, the slab shall be finished in accordance with the requirements of "Finish of Roadway Slabs".

420.17 Placing Concrete in Deck Girders Spans. Unless otherwise provided, the girders, slab and curbs of deck girder spans shall be placed in one

continuous operation. Concrete shall be placed in longitudinal sections. Placing preferably shall commence with a section adjacent to one curb, and successive sections continuing across the roadway shall follow. The width of each longitudinal section shall be governed by the size of the mixing apparatus and shall be such that each successive section shall be placed before the adjacent completed section shall have attained its initial set. The placing of concrete in curbs shall be in the proper sequence to be monolithic with the adjacent slab or girder section. Except for spans on a grade of 1-1/2 percent or more, concreting in each longitudinal section preferably shall be started at the middle of the span and shall be continued in both directions to the ends of the span. For spans on a grade of 1-1/2 percent or more, concreting shall be commenced at the low end of the span. The filling of the girder stems ahead of placing the concrete in the slab will be permitted provided the slab is placed not later than one hour after the filling of the girder stem.

During the operations of placing concrete in the span, the bottoms of the girders and overhanging slabs shall be maintained true to required vertical alignment. For convenience in checking the vertical alignment, the Contractor shall attach to the form of each girder an approved system of "tell-tales" which shall provide a means of matchmarking for reference to established grades fixed on stakes or other suitable reference points set independent of the forms and falsework for the span being placed. Care shall be exercised to assure that the "tell-tales" system is not altered or destroyed after the matchmarking is done.

On completion of the filling of the curb forms, the curbs shall be brought to the correct camber and alignment, and then shall be struck off and float finished.

The surface of the floor slab shall be finished as provided in Section, "Finish of Roadway Slabs". The finishing shall be done as soon as possible after the placing of concrete is completed in a section of slab of sufficient width to permit finishing operations.

- 420.18 Placing Concrete In Floors on Steel Spans. Before concrete floor slabs are placed on steel truss spans, the falsework under the span shall be released and the span swung free on its supports. The floor slab shall be placed symmetrically about the centerline of the span beginning at the center and working simultaneously toward each end, or beginning at the ends and working simultaneously toward the center. Where construction joints are provided at each panel point of the truss, variations from the above sequence will be permitted to the extent of one unsymmetrical panel; that is, concreting will be permitted in a panel on one side of the centerline of span provided that the corresponding panel on the opposite side of the centerline shall be the next panel placed.

Placing of the slab in each panel and the placing of the slab on steel I-beam spans shall be in accordance with the provisions of Section "Placing Concrete in Slab Spans".

Concrete placed around steel shapes shall be deposited on one side of the shape and shall be spaded or vibrated until it flushed up over the bottom flange on the opposite side of the member, after which, it may be placed on both sides to completion.

On completion of the filling of the curb forms, the curbs shall be brought to the correct camber and alignment, and they shall then be struck off and float finished as described in Section 420.21 "Treatment and Finishing of Horizontal Surfaces Except Roadway Slabs".

The surface of the floor slab shall be finished as provided in Section 420.22 "Finish of Roadway Slabs". The finishing shall be done as soon as possible after the placing of concrete is completed in a section of slab of sufficient width to permit finishing operations.

420.19 Placing Concrete in Box Culverts. In general, the base slab, curtain walls, lower haunches, and the bottom portion of the sidewalls up to a height approximately one inch above the haunches, or sidewalls to a height approximately 4 inches above the base slab when no haunch is provided, shall be placed as a monolith. The top surface of the base slab and the top surface of the top slabs which do not carry direct traffic shall be accurately finished by hand floating methods before the concrete has attained its initial set. Before concrete is placed in the sidewalls, the footing area joining the walls shall be thoroughly cleaned of all shavings, sticks, sawdust, or other extraneous material.

In the construction of box culverts less than 4 feet in clear height, the sidewalls and top slab generally shall be placed monolithic. When box culverts are greater than 4 feet in clear height, a construction joint may, if shown on the plans, be provided between the sidewalls and the top slab. In case no joint is provided, an interval of not less than 1 hour or more than 2 hours shall elapse between the placing of concrete in the walls, and concrete in the haunches and top slab, such interval to allow for shrinkage in the wall concrete. Curbs and haunches at tops of walls shall be placed monolithic with the top slab.

The tops of culvert slabs which are intended to carry direct traffic shall be finished and surface tested in accordance with the provisions for finishing roadway slabs.

420.20 Placing Concrete in Foundations of Structures. Concrete shall not be placed in footings until the depth and character of the foundation has been inspected by the Engineer and permission has been given to proceed.

The placing of concrete bases above seal courses will be permitted after the caissons or cofferdams are free from water and the seal course cleaned. Any necessary pumping or bailing during the concreting operations shall be done from a suitable sump located outside the forms.

All temporary wales or braces on the inside of cofferdams or caissons shall be constructed or adjusted as the work proceeds, so that construction joints in bases or shaft, in addition to those shown on the plans, will not be necessary.

Concrete in deep foundations shall be placed in a manner that will avoid separation of the aggregates or displacement of the reinforcement. Suitable chutes or vertical pipes shall be provided.

When footings can be placed in dry foundation pits without the use of cofferdams or caissons, forms may be omitted, if desired by the Contractor and approved by the Engineer, and the entire excavation filled with concrete to the elevation of the top of footing. Where this procedure is followed, no measurement for payment will be made for concrete placed outside of the footing dimensions shown on the plans.

Concrete in columns shall be placed monolithically unless otherwise provided. Unless a construction joint is provided at the top of columns, an interval of not less than 1 hour or more than 2 hours shall elapse between the placing of concrete in columns and the placing of concrete above the top of columns. Such interval is intended to allow for shrinkage of the column concrete.

420.21 Treatment and Finishing of Horizontal Surfaces, Except Roadway Slabs. All upper surfaces not covered by forms, such as tops of railing posts, railings, caps, curbs, parapets, copings, bridge seats, and sidewalk areas shall be completed by placing excess material in the forms and removing or striking off such excess with a wooden template forcing the coarse aggregate below the mortar surface. The use of mortar topping for surfaces under this classification will not be permitted.

After the concrete has been struck off as described above, the surface shall be thoroughly worked and floated with a wooden, canvas, or cork float. After floating and before the finish has set, all surfaces, except sidewalks so finished, shall be lightly striped with a fine brush, to remove the surface cement film, leaving a fine grained, smooth but sanded

texture. That portion of curbs or parapets which is to be the seat for concrete rail posts or webs of concrete railings shall be roughened in an approved manner.

420.22 Finish of Roadway Slabs. As soon as concrete placing operations have been completed for a longitudinal roadway slab section of sufficient width to permit finishing operations, the concrete shall be approximately leveled and then struck off, screeded and tamped by a longitudinal screed. The screed shall be of a design adaptable for the purpose intended. It shall have provisions for adjustment to the desired camber and be sufficiently rigid to hold true to shape during use.

The first strike-off operation shall leave the concrete surface at an elevation above grade so that, when consolidation and finishing operations are completed, the slab will be at the exact grade elevation shown on the plans with proper allowance for finished camber as hereinafter provided. The tamping and screeding operations shall be continued until the concrete is properly consolidated and surface voids eliminated. The surface shall then be brought to a smooth true alignment by means of longitudinal screeding, floating, belting, and/or other methods approved by the Engineer. Spans over 40 feet in length may be screeded in two or more sections if suitable intermediate templates are installed. Unless otherwise provided, the templates shall be of such design as to permit early removal in order to avoid construction joints and to permit satisfactory finishing at and adjacent to the site of the template.

After the finishing operations are completed and while the concrete is still plastic, the surface shall be straightedged by the Contractor, using a standard 10 foot metal straightedge. Any deviations from the face of the straightedge greater than those prescribed under the following surface test shall be corrected before the concrete has attained its initial set. The final belting of the slab shall be done after this straightedging is completed.

After the concrete has attained its final set, the roadway surface shall be tested again with a standard 10 foot metal straightedge for irregularities, and the surface shall be corrected, if necessary, to conform to the following:

The straightedge shall be placed parallel to the centerline of the road so as to bridge any depression and touch high spots. Ordinates measured from the face of the straightedge to the surface of the slab shall not exceed 1/16 inch per foot from the nearest point of contact and the maximum ordinate shall not be greater than 1/8 inch. The surface shall be corrected by grinding off the high spots as may be required in order to conform to these limits.

In the case of concrete slab or girder spans, the floor shall be finished so as to provide a camber sufficient to offset the dead load deflection of the span; other spans shall be so finished if directed by the Engineer. Unless otherwise shown on the plans, the camber at the center of the span shall be made 1/8 inch for each 10 feet of span length with a maximum camber of 1/2 inch. When camber is provided, the ordinate to the straightedge may be as much as 3/16 inch at the end of the straightedge but shall not exceed 1/16 inch under its center.

420.23 Curing Concrete. Careful attention shall be given by the Contractor to the proper curing of all concrete in the structure. The Contractor, at his/her option, may elect to use other curing methods outlined in the Item 421 "Structural Concrete". If cotton mats are used, all upper surfaces not formed, except roadway and side walk slabs, shall be covered by cotton mats immediately following the floating operations and shall be kept thoroughly wet for a period of 4 curing days after the concrete is placed. All formed surfaces requiring a surface finish shall be covered with wet cotton mats immediately after the forms are removed and shall be kept covered and wet until the concrete has aged at least 4 curing days. Intermission will be permitted as needed to allow the surfaces to be finished. The mats shall be held in direct contact with the concrete. Water used for curing shall be free from injurious amounts of oil, acid, alkali, salt, or other deleterious substances.

When forms are removed from concrete caissons in less than 4 curing days and when the sinking operations do not immediately follow the form removal, the caissons shall be cured by being covered with wet cotton mats which shall remain in place until the caissons have aged at least 4 curing days.

Immediately following the finishing operations, concrete roadway and sidewalk slabs shall be covered with wet cotton mats or with a temporary covering of canvas or burlap. The temporary covering will be required in all cases where the size of span, size of mats, or other factors are such that the mats cannot be placed immediately following the finishing operation without marring the finish of the slab.

The canvas or burlap covering material shall weigh not less than 10 ounces per square yard, and the sections shall be placed with a lap at the edges of at least 8 inches. The material shall be saturated with water previous to placing and shall be kept saturated as long as it remains in place. Care shall be exercised in the placing of the cover material in order that the concrete surface shall not be disturbed.

When a temporary covering is used, it shall remain in place only until the slab has sufficiently hardened that a cotton mat covering can be substituted without disturbing or marring the finish of the slab. Cotton mats shall be thoroughly saturated before placing and shall be maintained in a saturated condition for a period of at least 8 curing days after the concrete is placed.

Ponding, instead of cotton mat covering may be used for curing roadway, sidewalk slabs, and top slabs of culverts. In addition, membrane curing as specified in the Item 526 "Membrane Curing", may also be used, where appropriate.

420.24 Removal of Forms and Falsework. Except as hereinafter provided, forms for surfaces required to be finished shall be removed when the concrete has aged not less than 1/2 nor more than 2 curing days after the concrete is placed. In order to facilitate slab finishing, forms for inside curb faces on roadway slabs may be removed in not less than 3 hours if the concrete has set sufficiently to permit form removal without damage to the curbs.

Forms and falsework for the portions of structures which do not require surface finish may be removed when the concrete has aged for the minimum number of curing days set forth in the following table:

Forms and falsework under slabs or girders having span lengths of 10 feet and less	7 Days
Forms and falsework under slabs or girders having span lengths over 10 feet and less than 17 feet	7 Days plus one day for each foot of span over 10 feet
Forms and falsework under slabs or girders having spans over 17 feet in length	14 Days
Forms and falsework under caps or tie beams of framed bents	4 Days
Forms under caps of pile bents	4 Days
Forms & falsework under webwalls of piers	7 Days
Forms for walls, columns & sides of beams	4 Days
Forms for concrete caissons	2 Days

The term "curing day" will be interpreted as any calendar day on which the temperature is above 50°F for at least 19 hours. Colder days may be counted if satisfactory provision is made to maintain the air temperature adjacent to the concrete constantly above 50°F throughout the entire day.

In continued cold weather, when artificial heat is not provided, the Engineer may permit the removal of forms and falsework at the end of a period of calendar days equal to twice the number of curing days stated in the above table. Test specimens may be made, at the option of the Engineer, for the purpose of determining a satisfactory time of form and falsework removal in cold weather. When tests made on specimens cured under like conditions to the curing of the structure indicate that strengths equivalent to the 7 day strengths as given in the Item 421 "Structural Concrete" have been attained, the forms and falsework may be removed. In no event shall this removal be done in less time than the curing periods given in the above table.

Forms for the portions of slabs that cantilever more than one foot beyond the outside beams shall not be removed in less than four curing days, nor shall falsework under girders and bent caps for framed bents be removed in less than the minimum time specified regardless of requirements for surface finish. The above provisions relative to form removal shall apply only to forms or parts of forms which are so constructed as to permit removal without disturbing forms or falsework which are required to be left in place for a longer period on other portions of the structures.

- 420.25 Defective Work. Any defective work discovered after the forms have been removed shall be repaired immediately. If the surface of the concrete is bulged, uneven, or shows excess honeycombing or form marks, which defects, in the opinion of the Engineer, cannot be repaired satisfactorily, the entire section shall be removed and replaced. In repairing honeycombed areas, all loose material shall be removed before the repair work is started. No extra compensation will be allowed for the extra work or materials involved in repairing or replacing defective concrete.
- 420.26 Finishing Exposed Surfaces. All railing, curbs, the underside of overhanging slabs, the outside and bottom of exterior girders or fascia beams, and all portions of piers, columns, bents, abutments, retaining walls and culverts, which are exposed to view after backfill and roadway embankments are placed shall be surface finished. The area inside of culvert barrels including both sidewalls and the underside of the top slab for a distance equal to 1/3 the clear height but not less than 18 inches shall be considered as exposed to view. The remaining surface inside of culvert barrels, the underside of roadway slabs between exterior girders or beams, the sides and bottoms of interior superstructure girders and bottoms of slab spans will not be required to be surface finished unless such surfaces are not true or have porous spots or honeycombed areas. In case these defects occur, the areas shall be given a first surface rubbing.

The operation of surface finishing shall be in accordance with the following provisions:

As soon as forms are removed, all necessary pointing shall be done. When the pointing has set sufficient to permit it, all surfaces requiring surface finish shall be wet with a brush and given a first surface rubbing with a No. 16 Carborundum Stone or an abrasive of equal quality. The rubbing shall be continued sufficiently to bring the surface to a paste, to remove all form marks and projections, and to produce a smooth dense surface without pits or irregularities. The use of cement to form a surface paste will not be permitted. The material which has been ground to a paste in this process shall be carefully spread or brushed uniformly over the surface and allowed to take a reset.

In general chamfered corners shall not be rubbed in the first surface rubbing.

During the process of conditioning the completed structure for final acceptance, the surfaces of the entire structure requiring finish shall be cleaned free from drip marks and discolorations and shall be given a final finish rubbing with a No. 30 Carborundum Stone or an abrasive of equal quality. On completion of this rubbing, the surface shall be neatly striped with a brush, and the mortar on the surface shall be allowed to take a reset. The surface shall then be washed down with clean water. The entire structure shall be left with a clean, neat, and uniform appearing finish and shall be uniform in color.

The surfaces of concrete roadway and sidewalk slabs shall be finished by floating, screeding, and belting as provided in Section 420.22 "Finish of Roadway Slabs".

420.27 Special Surface Finishes. When so specified, special surface finishes shall be employed for ornamental panels, copings, and like construction. In general, the method and manner of performing this work will be fully provided for in the plans or special provisions to these Standard Specifications.

In case of special finishes, the Contractor will be required to prepare test or sample panels showing the method and manner of finish. The choice and selection of the aggregate and other features affecting the work shall be approved by the Engineer before any further work is done.

420.28 Measurement and Payment. No direct compensation will be made for "Concrete Structures". Measurement and payment for quantities of concrete, railing, piling, excavation and other proposal items, which

constitute the completed and accepted structure, will be made in accordance with the provisions of the pertinent specifications.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 421 "Structural Concrete"
Item 438 "Preformed Joint Seal"
Item 440 "Reinforcing Steel"
Item 526 "Membrane Curing"

END OF ITEM 420

ITEM 433

CEMENT STABILIZED SAND BEDDING AND BACKFILL MATERIAL

433.1 Description. This Item shall govern for cement stabilized sand to be used for backfill and bedding as called for on the Standard Civil Drawings, in other parts of the Standard Specifications, or as directed by the Engineer.

433.2 Materials. Cement shall be Type I Portland cement conforming to ASTM C150.

Sand shall be clean durable sand containing not more than the following:

A. Deleterious Materials

Clay lumps, when tested in accordance with ASTM C142 shall be less than 0.5 percent.

Lightweight pieces, when tested in accordance with ASTM C123 shall be less than 5.0 percent.

Organic impurities when tested in accordance with ASTM C40, shall not show a color darker than the standard color.

B. The plasticity index shall be 6 or less when tested in accordance with ASTM D4318.

C. Sand shall be free of organic matter and deleterious substances and shall meet the following gradation requirement.

Square Sieve Size	Percent Passing, By Weight
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3/8"	100%
No. 200	5 - 30%

Water shall be clean and clear, free of oils, acids, alkalis, organic matter or other deleterious substances and shall conform to the requirements of ASTM C94.

433.3 Sand-cement Mixture Product. The mixture shall consist of not less than 1.5 sacks of Portland cement per ton of material mixture as placed. The mixture shall contain sufficient water to hydrate the cement.

The cement, sand and water shall be mixed in a pugmill type mixer, which meets the approval of the Engineer. It shall be mixed for a minimum period of two minutes per batch.

433.4 Submittals and Responsibilities of the Contractor:

- A. Submit the proposed design mix and test data for cement stabilized sand mixture.
- B. Facilitate testing and inspection, by furnishing any necessary labor to assist the designated Testing Laboratory in obtaining and handling samples at the project site.

433.5 Placing. The sand cement mixture shall be placed in maximum 8 inch thick lifts, loose measure around the pipe, boxes, structures, bridge approaches and paving sections. Placement and compaction shall be performed in a manner that will thoroughly fill all voids without placing undue strain on or displacement of the structure.

Cement stabilized sand backfill placed below the top of sewers, manholes, inlets or other structures shall be placed equally along all sides of the structure. Cement stabilized sand backfill/bedding shall be placed in a manner that will completely fill all voids in the trench. Hand operated tampers may be used for compaction.

Materials not placed and compacted within 4 hours after mixing shall be rejected. Do not place or compact sand-cement mixtures in standing or free water.

Cement stabilized sand bedding and backfill placed in trenches shall be compacted in accordance with Item 02317 "Excavation and backfill of Utilities" and Item 480 "Precast Reinforced Concrete Box Sewers."

Provide excavation and trench safety system at locations and depths required for testing and retesting during construction, at no additional cost to Harris County.

In-place density tests shall be taken at each location, each day, to test the placement of bedding/backfill material. The minimum number of tests per day shall be 1 in-place density on the bedding and 2 in-place densities on backfill. The minimum number of tests shall be for each location at the rate of 1 in-place density test per 50 linear feet of bedding and 1 in-place density test per 50 linear feet of backfill per lift placed above the top of pipe. In-place densities shall be determined in accordance with ASTM D6938 or ASTM D1556 and ASTM D3017.

433.6 Performance. The sand cement mixtures shall produce a minimum unconfined compressive strength of 100 psi in 48 hours, when compacted to 95 percent of Standard Proctor density (ASTM D558), without additional moisture control and when cured in plastic bags at a temperature of 73.4° F. at plus or minus 3° F. and tested in accordance with ASTM D1633.

Random samples of the delivered product will be taken in the field at the direction of the Engineer and tested at Harris County's expense. A minimum of 1 sample per week shall be taken at random to represent a production that is less than 100 tons per week. Two samples per week

shall be taken at random to represent a production greater than 100 tons per week. The Engineer shall have the option to obtain additional samples for testing.

After the molding of the soil-cement cylinders, the specimens will be tested in accordance with ASTM D1633, Method A. Two specimens will be tested at 48 hours and two specimens will be tested at 7 days.

433.7 Notification. The Testing Laboratory's representative will notify the County, Engineer, Contractor and material supplier by facsimile of all tests indicating results falling below specified strength requirements.

433.8 Measurement. Cement stabilized sand shall be measured by the cubic yard of material, furnished and compacted in place to the thickness specified, or as shown in the plans or acceptable material mixture, as specified by this Item, shall be measured by the ton of 2,000 pounds. Measurement shall be made by tickets delivered to the Engineer. The dray tickets shall indicate the tare, gross and net weight of the load and the location of delivery.

433.9 Payment.

A. The payment for cement stabilized sand, complete and in place, shall be at the contract unit price per cubic yard of the specified thickness, which unit price shall include all costs of materials, furnished, hauled, dumped, spread, shaped, and compacted.

B. Where the bid sheet specifies FOB the plant, the materials shall be loaded on Harris County vehicles and paid for by the ton of 2,000 pounds.

C. Where the bid sheet specifies FOB the job, materials shall be transported to the job site specified on the bid sheet, and paid for by the ton of 2,000 pounds.

D. When the Project Manual, plans or other specifications indicate the use of cement stabilized sand is incidental to another pay item, no direct payment for the material will be made.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 02317 "Excavation and backfill for Utilities"

Item 480 "Precast Reinforced Concrete Box Sewers"

END OF ITEM 433

ITEM 440

REINFORCING STEEL

440.1 Description. This Item shall govern for the furnishing and placing of reinforcing steel of the type, size and quantity designated for use in structures, as shown on the plans and in accordance with these Standard Specifications.

440.2 Materials. Unless otherwise designated on the plans, or herein, all bar reinforcement shall be deformed and shall conform to the following:

- A. ASTM A615, Grade 40 or 60, open hearth, basic oxygen or electric furnace new billet steel.

Unless noted by these Standard Specifications, rail steel or axle steel shall not be permitted.

When no specific grade is specified on the plans, the reinforcing steel shall be a minimum Grade 60.

Grade 40 reinforcing steel shall be required for bent bars (e.g. "L" bars for driveway tie-in).

Where bending of bar sizes #14 or #18 of Grade 60 is required, bend testing shall be performed on representative specimens as described for smaller bars in the applicable ASTM Specification. The required bend shall be 90 degrees around a pin having a diameter of 10 times the nominal diameter of the bar.

- B. Spiral reinforcement shall be either smooth or deformed bars, or wire, of the minimum size or gage shown on the plans or as specified herein. Bars for spiral reinforcement shall comply with ASTM A675, A615 or A996. Wire shall conform to ASTM A1064.

Unless otherwise shown on the plans, the minimum yield strength for spiral reinforcement shall be 40,000 psi.

Report of chemical analysis, showing the percentages of carbon, manganese, phosphorus and sulphur will be required of all reinforcing steel bars when it is to be welded.

The nominal size and area and the theoretical weight of reinforcing steel bars covered by this Item are as follows:

TABLE 1

Bar Size #	Nominal Diameter In.	Nominal Area Square Inch	Weight per Linear Foot
2	0.250	0.05	0.167
3	0.375	0.11	0.376
4	0.500	0.20	0.668
5	0.625	0.31	1.043
6	0.750	0.44	1.502
7	0.875	0.60	2.044
8	1.000	0.79	2.670
9	1.128	1.00	3.400
10	1.270	1.27	4.303
11	1.410	1.56	5.313
14	1.693	2.25	7.65
18	2.257	4.00	13.60

- C. When wire is ordered by size numbers, the following relation between size number, diameter in inches and area shall apply unless otherwise specified:

TABLE 2

Size #	Nominal Diameter Inch	Nominal Area Square Inch
31	0.628	0.310
30	0.618	0.300
28	0.597	0.280
26	0.575	0.260
24	0.553	0.240
22	0.529	0.220
20	0.505	0.200
18	0.479	0.180
16	0.451	0.160
14	0.422	0.140
12	0.391	0.120
10	0.357	0.100
8	0.319	0.080
7	0.299	0.070
6	0.276	0.060
5.5	0.265	0.055
5	0.252	0.050
4.5	0.239	0.045
4	0.226	0.040
3.5	0.211	0.035
3	0.195	0.030
2.5	0.178	0.025
2	0.160	0.020

<u>Size #</u>	<u>Nominal Diameter Inch</u>	<u>Nominal Area Square Inch</u>
1.5	0.138	0.015
1.2	0.124	0.012
1	0.113	0.010
0.5	0.080	0.005

Where deformed wire is required the size number shall be preceded by D, and for smooth wire, the prefix W will be shown.

- D. Where plain steel wire is used for concrete reinforcement, it shall meet the requirements of ASTM A1064.

Fabricated deformed steel bar mats shall meet the requirements of ASTM A184, while plain steel welded wire fabric shall meet the requirements of ASTM A1064.

Deformed steel wire for concrete reinforcement and deformed steel welded wire fabric shall meet the requirements of ASTM A1064.

- 440.3 Bending. The reinforcement shall be bent cold, true to the shapes indicated on the plans. Bending shall preferably be done in the shop. Irregularities in bending shall be cause for rejection. Unless otherwise shown on the plans, bends shall be made in accordance with ACI 315.

Bends of 90° and greater in stirrups, ties and other secondary bars that enclose another bar in the bend, in terms of the nominal bar diameter (d), shall be as follows:

TABLE 3

	<u>Grade 40</u>	<u>Grade 60</u>
#3, #4, #5	4d	4d
#6, #7, #8	6d	6d

All bends in main bars and in secondary bars not covered above shall be as follows:

TABLE 4

	<u>Grade 40</u>	<u>Grade 60</u>
#3 through #8	6d	6d
#9, #10, #11	8d	8d
#14, #18	10d	10d

- 440.4 Fabricating Tolerances. Fabricating tolerances for bars shall be as indicated in ACI 315.
- 440.5 Storing. Steel reinforcement shall be stored above the surface of the ground upon platforms, skids or other supports and shall be protected from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross-sectional area and tensile proportions of a hand wire brushed specimen meets the physical requirements for the size and grade of steel specified.
- 440.6 Lap Splices. Splicing of bars, except where shown on the plans, will not be permitted without prior approval of the Engineer.

Splices, not provided for on the plans, will be permitted in slabs not more than 15 inches in thickness, columns, walls and parapets subject to the following:

Splices will be permitted in bars 30 feet or less in plan length. For bars exceeding 30 feet in plan length, the distance center to center of splices shall not be less than 30 feet minus one splice length, with no more than one individual bar length less than 10 feet. Splices not shown on the plans, but permitted hereby, shall be made in accordance with Table 5. The specified concrete cover shall be maintained at such splices and bars placed in contact and securely tied together. Lap bars so that both bars will be in the same plane parallel to the nearest concrete surface.

TABLE 5
MINIMUM LAP REQUIREMENTS

Size #	<u>Grade 40</u>	<u>Grade 60</u>
3	1' - 0"	1' - 0"
4	1' - 2"	1' - 9"
5	1' - 5"	2' - 2"
6	1' - 9"	2' - 7"
7	2' - 4"	3' - 5"
8	3' - 0"	4' - 6"
9	3' - 10"	5' - 8"
10	4' - 10"	7' - 3"
11	5' - 11"	8' - 11"

Spiral steel will be lapped a minimum of one turn.

Sizes #14 and #18 may not be lapped.

440.7 Welded Splices. Where shown on the plans or required by the provisions of this Item or other pertinent specifications, welded bar splices shall be used. All welding operations, processes, equipment, materials, workmanship and inspection shall conform to the American Welding Society Specification D1.4. For bars #6 and smaller, use lap weld splices with fillet welds equal to one half bar diameter on each side, for 4 inches in length. For bars #7 and larger, use butt weld splices in accordance with AWS D1.4.

All splices whether lap, weld, mechanical or coupler, shall develop the full strength of the bar. Information on mechanical splicing devices and couplers shall be submitted for approval prior to use.

440.8 Placing. Steel reinforcement shall be placed in the exact position as shown on the plans and held securely in place during the placing of the concrete. The dimensions shown are to centers of bars, unless otherwise noted. Hold bars securely in place with wire and other approved means during placement of concrete.

A. In plane of steel parallel to nearest surface of concrete, bars should not vary from plan spacing by more than one twelfth of spacing between bars.

B. In plane of steel perpendicular to nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch.

Space steel the required distance from forms or earth by approved galvanized metal spacers, metal spacers with plastic coated tips, stainless steel spacers, plastic spacers, or approved precast mortar or concrete blocks. For approval of plastic spacers, provide samples of plastic which show no indications of deterioration after immersion in a 5 percent solution of sodium hydroxide after 120 hours.

Use galvanized metal chairs to support all reinforcing steel, except that pavement steel chairs need not be galvanized. Use a heavy bolster to support bottom layer of reinforcing in abutment caps, bent caps and other beams.

In bridge deck slabs, use two rows of supports for bottom layer of reinforcing parallel to beams for each bay. Use high chairs to support top layer.

Reinforcing steel for bridge slabs, top slabs or direct traffic culverts and the top slabs of prestressed box beams shall be tied at all intersections, except that where the spacing is less than one foot in each direction, alternate intersections only need be tied. For reinforcing steel cages or other structural members, the steel shall be tied at enough intersections to provide a rigid cage of steel. Mats or wire fabric shall overlap each other one full space as a minimum to maintain a uniform strength and shall be fastened securely at the ends and edges.

Before any concrete is placed, all mortar, mud, dirt, etc., shall be cleaned from reinforcement. No concrete shall be deposited, until the Engineer has inspected the placement of the reinforcing steel and given permission to proceed.

440.9 Submittals. The following information shall be submitted for reinforcing steel. Six sets of each item shall be submitted.

- A. Product data for all materials used.
- B. Shop drawings indicating locations, placement, sizes and bending. Shop drawings shall be in accordance with the ACI Manual of Practice for Detailing Reinforced Concrete Structures.
- C. When welding is required, furnish report of chemical analysis, showing percentages of carbon, manganese, phosphorus and sulfur.
- D. Submit certified copies of mill certificates of compliance with requirements herein specified.
- E. Submit information on mechanical splicing devices, couplers, and all other reinforcing accessories.

440.10 Measurement & Payment. Reinforcing steel quantities will not be measured or paid for directly. All costs of furnishing, fabrication, placement, ties, chairs, bending, labor and equipment shall be considered subsidiary to bids for concrete structures, requiring reinforcement.

There are no line code(s), description(s), or unit(s) for this Item.

END OF ITEM 440

ITEM 495

REMOVING OLD STRUCTURES

495.1 Description. This Item shall govern for the removal and disposal of old structures or portions of structures such as bridges, headwalls, box culverts, pipes, timber structures, and other structures, as noted on the plans. This Item shall include all excavation and backfill necessary to complete the removal.

495.2 Method of Removal. Culvert or sewer pipe for reuse shall be removed by careful excavation of all material on the top and sides so that the pipe will not be damaged. Removal of sewer appurtenances shall be included for removal with the pipe. Those pipe which are deemed unsatisfactory for reuse, by the Engineer, will be removed and disposed of, off the job site, in any manner the Contractor may select.

When an existing concrete structure is to remain in use, the removal of any portions thereof shall be in accordance with the Item 424 "Extending Concrete Structures".

Concrete portions of structures below the permanent groundline shall be neatly squared off. Reinforcement shall be cut off close to the concrete.

Steel structures or steel portions of structures shall be dismantled in sections determined by the Engineer. The sections shall be of such weight and dimensions which permit convenient handling, hauling and storing. Rivets and bolts connecting steel rail members, steel beams or girder spans and steel stringers of truss spans will be removed by cutting the heads with a cold cut then punched or drilled by a method that will not injure the member for reuse and will meet the approval of the Engineer. The removal of rivets and bolts, from connections, will not be required unless specifically called for. Unless otherwise specified, the Contractor shall have the option of dismantling these members by flame cutting immediately adjacent to the connection. Flame-cutting will not be permitted when plans call for the structural unit to be salvaged in such a manner as to permit re-erection. In such case, all members shall be carefully dismantled without damage and match marked with paint in accordance with the plans and all rivets and belts shall be removed from the connections in the manner specified in this section.

Timber structures or timber portions of structures to be reused shall be removed with as little damage to the timber as possible. All bolts and nails shall be removed from such lumber as deemed salvageable by the Engineer.

Unless otherwise specified on the plans, timber piles shall be either pulled or cut off at a point not less than two feet below the groundline, or to final grade, with the choice between these two methods resting with the Engineer.

Brick or stone structures shall be removed by sledging the masonry into removal sizes. Portions of such structures below the permanent groundline, which will not in any manner interfere with the proposed construction, may be left in place, but removal shall be carried at least two feet below the permanent groundline and neatly squared off.

All material such as pipe, timbers, railing, etc. which the Engineer deems as salvageable for reuse and all structural steel shall be carefully placed in neat piles along the right-of-way at convenient loading points. All of these materials shall be the property of Harris County.

All timber structural members which are deemed unsatisfactory for reuse, by the Engineer, will be removed and properly disposed of at a permitted landfill. If the timber is treated wood, such as creosote, then the timber shall be disposed of as a hazardous waste, and a copy of the waste manifest shall be provided to the Engineer. The transportation and disposal cost for unsalvageable timber structural members shall be the responsibility of the Contractor. If temporarily stored on site until final disposition, all reusable timber members and waste timber members shall be blocked up off the ground and covered with a tarp.

The I-beams, girders, stringers, etc. which are to be put in storage or specified for reuse, shall be blocked up off the ground to protect the members against damage.

Materials which are not deemed salvageable by the Engineer, shall become the property of the Contractor and shall be removed and disposed of off the site by the Contractor. The Contractor is responsible for the proper protection of all materials that are salvageable.

All excavation made in connection with this Item and all openings below the natural groundline caused by the removal of old structures or portions thereof shall be back filled to the level of the original groundline, unless otherwise provided on the plans. No separate payment shall be made for backfill and it shall be considered subsidiary to this Item.

That portion of the backfill which will support any portion of the roadbed or embankment shall be placed in layers of the same thickness as those required for placing embankment. Material in each layer shall be wetted uniformly, if required, and shall be compacted to the density required in the adjoining embankment. In places inaccessible to blading and rolling

equipment, mechanical or hand tampers shall be used to obtain the required compaction.

That portion of the backfill which will not support any portion of the roadbed or embankment shall be placed as directed by the Engineer in such manner and to such state of compaction as will preclude objectionable amounts of settling.

495.3 Measurement. The work as provided for by this Item shall be measured as each individual structure to be removed, except that box culverts, pipes and water lines shall be measured by the linear foot. The removal shall include all appurtenances thereto.

495.4 Payment. The work as prescribed for in this Item shall be paid for at the unit price bid for "Removing Old Structures" per each or "Removing Old Box Culverts, Pipes or Water Lines" per linear foot, which price shall be full compensation for all work, labor, tools, equipment, excavation, backfilling, materials, disposal costs and incidentals necessary to complete the work.

There are line code(s), description(s) and unit(s) for this Item.

NOTE: This Item requires other Standard Specifications

Item 424 "Extending Concrete Structures"

END OF ITEM 495

ITEM 501

TREE PROTECTION AND TRIMMING

501.1 Description. This Item shall govern for the protection and trimming of trees indicated to be preserved. The Engineer shall note all trees designated for preservation. No tree whose trunk encroaches within 3' of the back of curb shall be preserved.

501.2 Quality Assurance. All tree removing, trimming and work within the tree's dripline shall be performed by or under the supervision of an arborist certified by the International Society of Arboriculture (ISA). The arborist shall indicate the trees that need to be removed, but no removal will be done without prior approval of the Engineer.

The Latest Edition of reference standards applicable to this Item are:

- A. ASTM D2665 "Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings".
- B. AWWA Standard U1 "Use Category System: User Specification for Treated Wood"

501.3 Job Conditions. The Contractor shall protect each tree designated to be preserved with a tree protection fence, installed in accordance with Item 559 "Construction Safety Fence" along the outside edge of the tree's dripline. The fencing shall be continuous between posts, shall be pulled taut prior to securing to posts, and shall be firmly attached to the posts with a minimum of 4 ties.

All tree protection fencing shall be installed prior to site work or construction activity. The fence shall be placed in a continuous alignment as shown on the tree protection plan or as approved by the Engineer.

Tree protection fencing shall be removed by the Contractor unless otherwise directed by the Engineer, at no additional costs, upon completion of all construction activity in each work zone area. Tree protection fencing materials used in the first work zone area(s) shall be removed and utilized in subsequent work zone areas. Materials and labor shall be paid for each linear foot of fencing installed in first two work areas. All fencing installed in subsequent work zone areas shall be paid for labor only.

Contractor shall not allow any vehicular traffic, parking of vehicles or stockpiling of excavated material or construction materials within 3 feet of the dripline of trees indicated to be preserved.

Construction equipment may operate within 3 feet of the dripline of a tree when necessary for the performance of indicated work; such operations shall be conducted with special care to avoid damaging the tree.

Water trees indicated to be preserved, as required to maintain their healthy growth during the course of construction operations (per Arborist recommendation).

501.4 Materials. Tree pruning compound shall be waterproof, antiseptic, elastic, and free of kerosene, coal tar, creosote, and other substances harmful to trees.

Topsoil shall be material free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, vegetation, and other deleterious matter.

Drainage fill shall be selected stone or gravel, graded to pass a 3 inch sieve and retained on a 1 inch sieve.

Physical barriers, if required, shall be constructed from the following material:

- A. Wood Components: Number 2 Pine, pressure treated to prevent decay for 1 year in accordance with the requirements AWWA Standard U1, suitable for Use Category 4B.
- B. Fence Material: Fence shall be comprised of extruded, high density polypropylene, 4 foot tall minimum and orange in color. The mesh openings shall be no larger than 3-1/2 inches x 1-1/2 inches. T-posts shall be made of fiberglass or steel and shall be 6 feet long (minimum).
- C. Banding: Stainless steel or varnish coated carbon steel, 3/4 inch wide x 26 gauge.
- D. PVC pipe shall conform to ASTM D2665 and be 4 inch o.d., nominal.

501.5 Execution. The Contractor shall protect tree root systems from damage due to noxious materials in solution caused by run-off or spillage during mixing and placement of construction materials, or drainage from stored materials.

The Contractor and/or any of the Contractor's workers shall not park vehicles under trees, nor perform vehicle maintenance under trees.

If required, remove branches from trees indicated to be preserved to clear for new construction. All cuts should be made sufficiently close to the parent limb or trunk without cutting into the branch collar or leaving a protruding stub, so that closure can readily start under normal conditions. All lateral cuts shall be made back to a lateral that is at least 1/3 the diameter of the parent limb. Clean cuts shall be made at all times. Where directed by the Engineer, extend the pruning operation to restore the natural shape of the entire tree.

Cut branches and roots with sharp pruning instruments. Do not break or chop branches and roots. Paint cuts over 1/2 inch in size with tree pruning compound. Apply black latex paint to all fresh wounds on Oak (Quercus) species immediately after each cut is made.

- 501.6 Pruning. Pruning shall be completed by ISA (International Society of Arboriculture) certified arborist who has received training in proper pruning techniques. Prior to construction, all deciduous trees indicated to be preserved shall be pruned of new or recent growth to maintain the basic branching form of the trees. Extent of pruning shall be based upon the proximity of pavement to the trunk and the size of tree blockouts and the requirements for construction adjacent to the tree.

Trees having branches which extend to the ground at their outermost limit shall have such branches pruned to a height equal to the height of all vehicles requiring access below or around such trees. Provide minimum of 14 feet and maximum of 18 feet of vertical clearance over proposed street construction. The Contractor shall notify property owner in writing 48 hours prior to trimming or pruning any trees on private property for privately owned trees extended into County right-of-way.

Pruning shall be limited as much as possible to young branches. Care shall be taken to maintain older branches which provide the basic form of the tree.

- 501.7 Excavation Around Trees. Excavate within the dripline of trees only where indicated. Where trenching for utilities is required within dripline, tunnel under or around roots by hand digging. Do not cut main lateral roots or tap roots. Smaller roots which interfere with the installation of new work may be cut.

Where excavating for new construction is required within the dripline of trees, hand excavate to minimize damage to the root system. Provide sheeting at excavations if required. Use narrow spading forks and comb soil to expose roots.

Relocate roots in backfill areas wherever possible. If large main lateral roots are encountered, expose beyond excavating limits as required to bend and relocate without breaking. If roots are immediately adjacent to location of new construction and relocation is not practical, cut roots approximately 3 inches back from new construction.

Do not allow exposed roots to dry before permanent backfill is placed. Provide temporary earth cover, or pack with peat moss and wrap with burlap. Water and maintain exposed roots in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.

Prune branches to balance loss to root system caused by damage or cutting, per arborist recommendations.

501.8 Grading and Filling Around Trees. Maintain the existing grade within the dripline of trees, unless otherwise indicated.

Where the existing grade is above the new finish grade around trees, carefully hand excavate within the dripline to new finish grade. Cut roots exposed by excavation and provide permanent protection as recommended by the certified arborist.

Where the existing grade is 3 inches or less below new finish grade, use a topsoil fill material. Place the topsoil in a single layer and do not compact. Hand grade to the required elevation.

Where existing grade is more than 6 inches below new finish grade, provide 1 inch, schedule 40 PVC pipe, 6 feet on centers around tree perimeter, at dripline for aeration of the root system.

501.9 Repair of Trees. When trees indicated to be preserved are damaged by construction operations, remove the damaged portions as soon as possible to prevent progressive deterioration. Repair work shall be subject to the approval of the Engineer.

Remove and replace dead or damaged trees designated to be preserved which are determined by the certified arborist to be incapable of restoration to normal growth status.

501.10 Submittal Requirement. The Contractor shall submit the qualifications of ISA certified arborist for Engineer's approval.

501.11 Measurement and Payment. Measurement and payment for tree protection and trimming shall be by the lump sum or by each in accordance with the bid proposal.

Removal of trees shall be paid for as provided in the bid proposal in accordance with Item 102 "Clearing and Grubbing".

Tree protection with barrier (orange fence) shall be measured and paid per each or per linear feet in accordance with bid proposal.

There are line code(s), description(s), and unit(s), for this Item.

NOTE: This Item does require other Standard Specifications.

Item 102 "Clearing and Grubbing"
Item 159 "Construction Safety Fence"
Item 725 "General Source Control"

END OF ITEM 501

ITEM 526

MEMBRANE CURING

526.1 Description. This Item shall govern for curing concrete pavement, concrete base, curbs, curb and gutters, sidewalks, driveways, medians, islands, mowing strips, ADA ramps, concrete structures and slope paving, by the impervious membrane method.

526.2 Materials. The membrane curing compound shall comply with ASTM C309 "Standard Specification for Liquid Membrane Curing Compounds, for Curing Concrete", Type 2. White pigmentation shall be used on concrete paving. Red or clear pigmentation shall be used on structures. The material shall not have a flash point less than 50⁰ F when tested by ASTM D56, "Test Method for Flash Point by Tag Closed Cup Tester".

The material shall be of such consistency that it can be satisfactorily applied as a fine mist through an atomizing nozzle by means of approved pressure spraying equipment at atmospheric temperatures above 40⁰F.

The material shall be of such nature that it will not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete, or its components.

The compound shall not settle out excessively or cake in the container and shall be capable of being mixed to a uniform consistency by moderate stirring and shall exhibit a daylight reflectance of not less than 60% of that of magnesium oxide, when tested in accordance with ASTM E1347 "Test Method for Color and Color-Difference Measurement by Tristimulus Filter) Colorimetry".

The compound shall produce a firm, continuous, uniform moisture-impermeable film, free from pinholes and shall adhere satisfactorily to the surfaces of damp concrete. It shall, when applied to the damp concrete at the rate specified by the manufacturer, dry to touch in not more than 4 hours and shall not be tacky or track off concrete after 12 hours. It shall be a tenacious film without running off or appreciably sagging. The compound shall not disintegrate, check, peel, or crack during the required curing period. The compound shall not peel or pickup under traffic and shall disappear from the surface of the concrete by gradual disintegration.

The compound shall be delivered to the job only in the manufacturer's original containers, which shall be clearly labeled with the manufacturer's name, the trade name of the material and a batch number or symbol with which test samples may be correlated.

The permissible percentage moisture loss when tested for water retention by ASTM C156 "Test Method for Water Retention by Concrete Curing Materials" shall not exceed:

24 hours after application 2 percent

72 hours after application 4 percent

526.3

Construction Methods. Keep the concrete pavement surface from drying until the curing material has been applied. The membrane curing compound shall be applied after the surface finishing has been completed and immediately after the free surface moisture has disappeared. The surface shall be sealed with two uniform coatings of the specified type of curing compound applied at an individual application rate of 1 gallon per 180 square feet of area or as specified by the manufacturer. The Contractor shall provide satisfactory means and facilities to properly control and check the rate of application of the compound. Use a towel or absorptive fabric to remove any standing water that may be present on the surface before applying the curing compound. Apply the first coat within 10 minutes after completing texturing operations. Apply the second coat within 30 minutes after completing texturing operations.

The compound shall be thoroughly agitated during its use and shall be applied by means of approved mechanically powered pressure sprayers. The sprayers used to apply the membrane to concrete pavement shall travel at a uniform speed and be mechanically driven. The equipment will be of such design that it will ensure uniform and even application of the membrane material. The sprayers shall be equipped with satisfactory atomizing nozzles.

Hand powered straying equipment will be permitted only on small miscellaneous items.

For all spraying equipment, the Contractor shall provide facilities to prevent the loss of the compound between the nozzle and the concrete surface during the spraying operations.

The compounds shall not be applied to a dry surface and if the concrete has become dry, it shall be thoroughly moistened prior to application of membrane by fogging or moist application. Sprinkling or coarse spraying will not be allowed.

At locations where the coating shows discontinuities, pinholes or other defects, or if rain falls on the newly coated surface before the film has dried sufficiently to resist damage, an additional coat of the compound shall be applied immediately at the same rate of coverage specified herein.

To insure proper coverage, the Engineer shall inspect all treated areas after application of the compounds for the period of time designated in the governing specification for curing, either for membrane curing or for other methods. Dry areas are identifiable because of the lighter color of dry concrete as compared to damp concrete. All suspected areas shall be tested by placing a few drops of water on the suspected areas. If the water stands in rounded beads or small pools which can be blown along

the surface of the concrete without wetting the surface, the water impervious film is present. If the water wets the surface of the concrete as determined by obvious darkening of the surface, or by visible soaking into the surface, no water impervious film is present. Should the foregoing test indicate that any area, during the curing period is not protected by the required water impervious film, an additional coat or coats of the compound shall be applied immediately, and the rate of application of the membrane compound shall be increased until all areas are uniformly covered by the required water impervious film.

When temperatures are such as to warrant protection against freezing, curing by this method shall be supplemented with an approved insulating material capable of protecting the concrete for the specified curing period.

If at any time there is a reason to believe that this method of curing is unsatisfactory or is detrimental to the work, the Contractor, when notified, shall immediately cease the use of this method and shall change to curing by one of the other methods specified e.g. use of burlap polyethylene material or cotton mats or burlap mats with polyethylene sheeting, in close contact with the concrete surfaces as approved by the Engineer.

526.4 Submittal Required. The Contractor shall submit the vendor's data for the curing compound to be used for Engineer's approval. He/she shall also submit the manufacturer's recommended method of application.

526.5 Measurement & Payment. Work and materials prescribed herein will not be paid for directly but shall be included in the unit price bid for the items of construction in which those materials are used.

There are no line codes for this Item.

NOTE: This Item requires other Standard Specifications

Item 420 "Concrete Structures"
Item 360 "Concrete Pavement"

END OF ITEM 526

ITEM 530

CONCRETE CURB AND/OR GUTTER,
SIDEWALKS AND DRIVEWAYS

530.1 Description. This Item shall govern for curb, monolithic curb and gutter, sidewalks and/or driveways, with or without reinforcing steel, composed of Portland cement concrete constructed on approved subgrade, foundation material, or finished surface in accordance with the lines and grades established by the Engineer and in conformance with the details shown on the plans. ADA compliance is required for sidewalks and ramps.

As used in this Item the word "curb" refers to standard 6 inch, doweled, and mountable concrete curbs, and monolithic curb and gutter.

530.2 Materials. Concrete used in conventionally formed construction shall be minimum Class D2 concrete, meeting the requirements of Item 360 "Concrete Pavement". Concrete for extruded construction shall also be minimum Class D2.

Cement mortar shall conform to ASTM C270, Type M. Aggregate for mortar shall conform to ASTM C144.

Fly ash may be used with the cement. Cement plus fly ash shall be composed of Portland cement, of the type specified herein, and a maximum of 25 percent fly ash by absolute weight. It is recommended that the percent of fly ash by weight be reduced to a maximum of 20 percent during cold weather concreting (average ambient temperature, over a 24 hour period after placement, less than 50°F). Fly ash shall be Class C or Class F conforming to the requirements of ASTM C618 "Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete". Fly ash shall have a minimum CaO content of 20 percent.

Reinforcing steel shall conform to the requirements of Item 440 "Reinforcing Steel".

Membrane curing materials shall meet the requirements of the Item 526 "Membrane Curing".

Bank sand, used as bedding material for concrete sidewalks, shall meet the requirements of Item 402 "Bank Sand Backfill".

530.3 Construction Methods. Any required excavation and backfill shall be completed in accordance with Item 400 "Structural Excavation" and Backfill", except for measurement and payment, and/or in accordance with Item 110 "Roadway Excavation" and Item 132 "Embankment".

For conventionally formed concrete, the subgrade, foundation, or pavement surface shall be shaped to the line, grade and cross-section

and if considered necessary by the Engineer, hand tamped and sprinkled. If dry, the subgrade or foundation material shall be sprinkled lightly immediately before concrete is deposited thereon.

Outside forms shall be of wood or metal, of a section satisfactory to the Engineer, straight, free of warp and of a depth equal to the depth required. They shall be securely staked to line and grade, and maintained in a true position during the depositing of concrete. Inside forms for curbs shall be of approved material, shall be of such design as to provide the curb required and shall be rigidly attached to the outside forms.

The reinforcing steel and/or dowels, if required, shall be placed in the position shown by the plans. Care shall be exercised to keep all steel in its proper location.

After the concrete has been struck off and after it has become sufficiently set, the exposed surfaces shall be thoroughly worked with a wooden float. The exposed edges shall be rounded by the use of an edging tool to the radius indicated on the plans. Unless otherwise specified on the plans, when the concrete has become sufficiently set, the inside form for curbs shall be carefully removed and the surface shall be plastered with a mortar consisting of one part of Portland cement and two parts of fine aggregate. The mortar shall be applied with a template made to conform to the dimensions as shown on the plans. All exposed surfaces shall be brushed to a smooth and uniform surface.

Sidewalks shall be constructed in sections of the lengths shown on the plans. Unless otherwise provided by the plans, no section shall be of a length less than 8 feet and any section less than 8 feet shall be removed by the Contractor at his own expense. The different sections shall be separated by a premolded or board joint of the thickness shown on the plans, placed vertically and at right angles to the longitudinal axis of the sidewalk. Where the sidewalks or driveways abut a curb or retaining wall, approved expansion material shall be placed along their entire length. Similar expansion material shall be placed around all obstructions protruding through sidewalks or driveways. Sidewalks shall be marked into separate sections, each 4 feet in length, by the use of approved jointing tools. The reinforced concrete sidewalk shall be placed on a bedding material of bank sand, at a minimum of 2" thick.

Curbs, gutters and curb and gutters shall be placed in sections of 80 foot maximum length unless otherwise shown on the plans. Joints shall be constructed at such locations and of the type as directed and specified on the plans.

All concrete placed under this Item shall contain 4% + 1-1/2% entrained air. The completed work shall be cured for a period of not less than 72 hours in accordance with the requirements of the Item 526 "Membrane Curing". Color of concrete shall be in accordance with Item 531 "Coloring Concrete for ADA Ramps".

Extruded Concrete Curbs:

For extruded concrete construction, the concrete shall be placed by an extrusion machine approved by the Engineer. When placement is directly on subgrade or foundation materials the foundation shall be hand-tamped and sprinkled if considered necessary by the Engineer. If the concrete is placed directly on the surface material or pavement, such surface shall be thoroughly cleaned. If required by plan details, the cleaned surface shall then be coated with an approved or other coating as specified at the rate of application per vendor recommendations.

The horizontal alignment shall be maintained from a "guide" line set by the Contractor. The alignment shall strictly conform to the details shown on the plans. The forming tube of the extrusion machine shall be readily adjustable vertically, during the forward motion of the machine to provide variable heights necessary to conform to the established grade line. To provide a continuous check on the grade, a pointer or gauge shall be attached to the machine in such a manner that a comparison can be made between the extruded work and the grade line. Other methods may be used if approved by the Engineer.

The mix shall be fed into the machine in such a manner and at such consistency that the finished work will present a well compacted mass with a surface free from voids and honeycomb and true to the established shape, line and grade.

Any additional surface finishing specified and/or required, shall be performed immediately after extrusion. Joints shall be constructed at such location as directed by the Engineer and to the details shown on the plans.

530.4 Measurement. Work and accepted material as prescribed by this Item for concrete curb, will be measured by the linear foot, complete in place.

Work and accepted material as prescribed by this Item for concrete sidewalks shall be measured by the square yard of surface area, complete in place including bank sand bedding material, as indicated on the plans.

Work and accepted material as prescribed by this Item for ADA curb ramps shall be measured by units of each, or square yard of surface area at specified depth, complete in place. When required, the Contractor's coordination of a TDLR inspection shall be an integral part of each ADA compliant sidewalk construction site.

Work and accepted material as prescribed by this Item for concrete driveways, shall be measured by the square yard of surface area, at specified depth complete in place.

530.5 Payment. The work performed and the materials furnished as prescribed by this Item and measured as provided under measurement will be paid for at the unit price bid for:

- "Concrete Curb" of the type indicated on the plans
- "Concrete Sidewalks" of the width, and type indicated on the plans.
- "ADA Curb Ramps"
- "Concrete Driveways"

The price for each item shall be full compensation for:

- Cleaning and coating the base
- Furnishing and applying all water, mortar, adhesives or other material, including reinforcing steel and dowel bars, if required
- For furnishing, loading and unloading, storing, hauling and handling all ingredients, including all freight and royalty involved
- For mixing, placing, finishing, sawing, cleaning and sealing joints and curing all concrete
- For furnishing all materials for sealing joints and placing joints and joint filler material in proper position
- For all manipulations, labor, equipment, appliances, tools, traffic provisions and incidentals necessary to complete the work.

There are line code(s), description(s), and unit(s) for this Item.

NOTE: This Item requires Standard Civil Drawings that shall be incorporated into the contract documents.

NOTE: This Item requires other Standard Specifications.

Item 110 "Roadway Excavation"
Item 132 "Embankment"
Item 360 "Concrete Pavement"
Item 400 "Structural Excavation"
Item 402 "Bank Sand Backfill"
Item 440 "Reinforcing Steel"
Item 526 "Membrane Curing"
Item 531 "Coloring Concrete for ADA Ramps"

END OF ITEM 530

ITEM 560

MAINTENANCE AND CLEANUP OF THE PROJECT SITE

560.1 Description. This Item shall govern for the maintenance and cleanup of the jobsite both during the term of the construction and at the end of construction.

560.2 General Requirements. The Contractor is required to remove from the job site and dispose of all trash, excess materials, etc., accumulated as a result of and during this work in compliance with current local, State and Federal Regulations.

At such time (daily or weekly) as directed by the Engineer, the Contractor shall remove any debris, trash or excess material off the site. He shall make every effort to keep the site in a neat, presentable condition, at all times.

In addition, at the end of each month, the entire construction site shall be generally cleaned and all trash and material over the length of the site shall be removed off site to the complete satisfaction of the Engineer.

The Contractor will mow, trim and edge the right-of-way and medians on the project for the entire project duration. The mowing schedule shall be as follows:

April – October:	Once per month
November – March:	Once every six weeks

After the construction work has been completed, the Contractor shall remove all debris, trash, excess materials, forms, stakes, empty sacks etc. from the site and leave the site with a neat appearance. All excavation shall be backfilled and all excess excavated material shall be disposed of off the site of the work.

560.3 Measurement and Payment. There shall be no separate payment for this Item.

There are no line code(s), description(s), or unit(s) for this Item.

END OF ITEM 560

ITEM 725

GENERAL SOURCE CONTROLS (SWPPP)

725.1 Description. This Item shall govern for erosion protection and sediment control related practices which shall be utilized during construction operations.

725.2 Materials. Topsoil shall conform to Item 160 "Topsoil".

The Contractor is required to inform the Engineer of the location of the pit or pits from which the material is to be taken. Harris County shall have the right to have an independent testing laboratory test the material to determine if it meets these Standard Specifications.

725.3 Construction Methods. No clearing and grubbing or rough cutting, other than as specifically directed by the Engineer to allow for soil testing and surveying, shall be permitted until sediment control and erosion protection systems are in place.

The Contractor shall prohibit equipment and vehicles from maneuvering on areas outside of dedicated rights of way and easements for construction. Damages caused by construction traffic to erosion and sedimentation control systems shall be repaired immediately.

Topsoil for Erosion and Sedimentation Control Systems:

When topsoil is called for as a component of another item, Contractor shall conduct erosion control practices during topsoil operation. When applying topsoil, Contractor shall maintain erosion and sediment control systems, such as swales, berms, dikes, and sediment basins. Contractor shall place the topsoil to the lines and grades and to the depths shown on the construction plans.

After the areas to receive topsoil have been brought to grade and immediately prior to dumping and spreading the topsoil, the subgrade shall be loosened by discing or by scarifying to a depth of at least 2 inches, to permit bonding of the topsoil to the subsoil. Contractor shall compact by passing a bulldozer up and down the slope, tracking over the entire surface area of the slope to create horizontal erosion control slots. When grading, filling, and applying topsoil around trees, Contractor shall maintain the existing grade within the drip line of trees, unless otherwise indicated.

Topsoil shall be material free of clay, rock or gravel larger than 2 inches in any dimension, debris, waste, vegetation and other deleterious matter. Drainage fill shall be selected stone or gravel, graded to pass a 3 inch sieve and retained on a 1 inch sieve.

No sod, seed, or other vegetation shall be placed on soil that has been treated with soil sterilants until sufficient time has elapsed to permit dissipation of toxic materials.

Protection of Trees in Construction Area:

Contractor shall employ protective measures to avoid damage to existing trees to be retained on the project site. Heavy equipment, vehicular traffic, and stockpiles of construction materials, including topsoil, are not permitted within 3 feet of the dripline of any tree to be retained. Specimen trees shown on the construction plans shall be boxed or fenced for protection. Contractor shall water those trees indicated to be preserved, as required, to maintain their healthy growth during the course of construction operations. Contractor shall protect tree root systems from damage due to noxious materials in solution caused by runoff or spillage during mixing and placement of construction materials or drainage from stored materials.

When called for in the construction plans, tunneling under the root system for the installation of utility lines shall be accomplished by hand digging. Contractor shall not allow exposed roots to dry before permanent backfill is placed. Tree trunks, exposed roots, and limbs of the trees designed to be retained which are damaged during construction operations will be cared for as prescribed by an arborist certified by the International Society of Arboriculture (ISA), at the expense of the Contractor. The Contractor shall extend the pruning operation to restore the natural shape of the entire tree. Main lateral roots, taproots, or old main branches shall not be cut or pruned. The Contractor shall cut branches and roots with sharp pruning instruments. He shall not break or chop branches and roots. Cuts over 1/2 inch in size shall be painted with tree pruning compound. Tree pruning compound shall be waterproof, antiseptic, elastic, and free of kerosene, coal tar, creosote and other substances harmful to trees.

Dust Control:

Control dust blowing and moving on construction sites and roads for erosion and sediment control, to prevent exposure of soil surfaces, to reduce on and off site property damage, to prevent health hazards, and to prevent hazardous sight conditions. Control dust blowing by utilizing one or more of the following methods:

1. Mulches bound with natural or chemical binders such as Soiltac®, Terratack®, or equal, as approved by the Engineer.
2. Temporary or permanent vegetative cover.
3. Spray-on adhesive, such as Soil Master®, PennzSuppress®, Soil Sement®, or equal, on mineral soils when not used by traffic and as approved by the Engineer.
4. Tillage to roughen surface and bring clods to the surface.
5. Irrigation by water sprinkling.
6. Barriers using solid board fences, snow fences, burlap fences, crate walls, bales of hay, or similar materials.

Dust control methods shall be implemented immediately whenever dust can be observed blowing on the project site.

Equipment Maintenance and Repair:

Maintenance and repair of construction machinery and equipment shall be confined to areas specifically designated for that purpose. Designated areas shall be located, designed, and maintained so as oils, gasoline, grease, solvents, and other potential pollutants cannot be washed into the storm sewer system or any other receiving stream. Contractor shall not allow oils, gasoline, waste fluids, and other potential pollutants to spill onto the soil or seep into the ground and groundwater. Adequate waste disposal receptacles shall be provided for liquid waste, as well as solid waste. Proper spill response measures and materials will be the responsibility of the Contractor. Designated maintenance areas shall be inspected and properly maintained daily.

On a site where designated equipment maintenance and repair areas are not feasible, care shall be taken during each individual repair or maintenance operation to prevent spills of potential pollutants. All applicable local, State and Federal Regulations shall be followed for the proper handling, storage, and waste disposal of oils, gasoline, grease, solvents, and other designated potential pollutants associated with the maintenance and repair of construction machinery and equipment.

Waste Collection and Disposal:

A plan shall be implemented for the collection and disposal of on site general trash, as well as construction debris. Disposal of waste materials shall be in compliance with current local, State and Federal Regulations. Trash and debris shall not be allowed to overflow its receptacle or accumulate for excessively long periods of time. Receptacles shall be located where they will least likely be affected by storm water runoff. Trash and construction debris shall not be burned on the project right-of-way.

Special provisions shall be made for the collection and disposal of liquid, toxic, or hazardous materials.

Sanitary Facilities:

Adequate sanitary facilities shall be provided for workers. Sanitary collection and disposal shall be in compliance with current local, State and Federal Regulations.

Vehicle Washing:

Construction equipment and vehicles, such as concrete trucks, shall be washed in designated areas only, as approved by the Engineer. These designated wash areas shall be designed and maintained such as to prevent runoff from leaving the site, as well as preventing the runoff from entering a storm sewer system or into a watercourse. The designated areas shall be located where the wash water will evaporate or infiltrate directly into the ground and where runoff can be collected in a temporary holding or seepage basin. Wash areas shall not be located immediately

adjacent to a storm sewer system or other watercourse or near a designated jurisdictional wetland. Concrete waste shall be permitted to dry in a controlled pit, sump, or other, and the waste shall be removed from the project site.

Storage of Construction Materials and Chemicals:

Storage of chemicals, cements, solvents, paints, pesticides, herbicides, fuels, or other potential pollutants shall be stored so that they will not be in contact with storm water runoff or cause potential leachate to the soil or groundwater. These items shall not be stored adjacent to a storm sewer system or other watercourse. Storage and use shall be in compliance with current local, State and Federal Regulations, as well as manufacturer's guidelines.

Contractor shall have a spill response program which addresses spills of construction related hazardous and toxic materials.

Demolition Areas:

Demolition projects usually generate large amounts of dust with significant concentrations of heavy metals and other toxic pollutants. Dust control techniques shall be used to limit the transport of the airborne pollutants. Water or slurries used to control dust shall not be allowed to flow into the storm sewer system or other watercourse.

Street Cleaning:

Street cleaning, such as sweeping, vacuuming, or shoveling, shall be provided along project area roadways where erosion have deposited or construction traffic have tracked sediments, mud, or debris. Contractor shall inspect the roadways daily, and perform the cleaning on a daily basis, if necessary. Washing or flushing of sediments, mud, or debris into adjacent drainage systems is prohibited.

Dewatering:

The pumping of ponded storm water, or other waters, from the project site directly into an adjacent watercourse or storm sewer system shall not be permitted unless the water has been pretreated through a sediment basin or other method, and as approved by the Engineer.

Pesticides, Herbicides, and Fertilizers:

Contractor shall only use pesticides, herbicides, and fertilizers on the construction site as indicated in the construction specifications and plans or as approved the Engineer. Pesticides, herbicides, and fertilizers shall be stored, used, applied, and disposed of in accordance with manufacturer's guidelines and with local, state, and federal regulations. Contractor shall not dispose of the pesticide, herbicide, and fertilizer wastes, and containers, on site or in the storm sewer system or other watercourse.

725.4

Measurement and Payment. No separate payment shall be made for this Item. The work performed under this Item shall be paid for and considered subsidiary to Item 751 "SWPPP Inspection and Maintenance".

There are no line codes for this Item.

NOTE: This Item requires other Standard Specifications.

Item 160 "Topsoil"

Item 751 "SWPPP Inspection and Maintenance"

END OF ITEM 725

SECTION 01300

SUBMITTALS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Procedural requirements for Work-related submittals including Construction Progress Schedules, Shop Drawings, product data, samples, operation and maintenance (O&M) data, construction photographs, schedule of values and other miscellaneous Work-related submittals.

B. Measurement and Payment:

1. Consider Work specified in this section incidental and include cost as part of the appropriate unit prices specified in Bid Form.

1.02 DEFINITIONS

A. Submittal for Review:

1. Submittal for ENGINEER'S and OWNER'S review in accordance with requirements of Contract Documents.

B. Submittal for Record:

1. Submittal for inclusion into OWNER'S records prior to Substantial Completion. Submittal will only be reviewed by ENGINEER at the Owner's request.

1.03 CONSTRUCTION PROGRESS SCHEDULES

- A. Prepare and submit Construction Progress Schedule in accordance with General Conditions.

1.04 SHOP DRAWINGS AND PRODUCT DATA

A. Scheduling:

1. Prepare and transmit each submittal sufficiently in advance of scheduled performance of Work and other applicable activities.

B. CONTRACTOR'S Responsibilities:

1. Review Shop Drawings and product data prior to submittal.
2. Contractor shall submit shop drawings and product data to the ENGINEER. No submittal will be approved without reviews by both the ENGINEER and OWNER.
3. Determine and verify following.
 - a. Field measurements.
 - b. Field construction criteria.
 - c. Catalog numbers and similar data.
 - d. Conformance with Specifications.
4. Coordinate each submittal with requirements of Work and Contract Documents.

SUBMITTALS

5. Notify ENGINEER in writing, at time of submittal, of deviations in submittals from requirements of Contract Documents.
6. Begin no fabrication or Work requiring submittals until return of submittals with ENGINEER approval.
7. Submittals received but not requested in Specifications may be returned without review.

C. Submittals shall contain:

1. Date of submittal and dates of previous submittals.
2. Project title and number.
3. Contract identification.
4. Names of:
 - a. CONTRACTOR.
 - b. Supplier.
 - c. Manufacturer.
5. Identification of product, with identification numbers, and Drawing and Specification section numbers.
6. Field dimensions, clearly identified.
7. Identify details required on Drawings and in Specifications.
8. Show manufacturer and model number, give dimensions, and provide clearances.
9. Relation to adjacent or critical features of Work or materials.
10. Applicable standards, such as ASTM or Federal Specification numbers.
11. Identification of deviations from Contract Documents.
12. Identification of revisions on resubmittals.
13. 8-in. by 3-in. blank space for CONTRACTOR and ENGINEER stamps.
14. CONTRACTOR'S stamp, signed, certifying to review of submittal, verification of products, field measurement, field construction criteria, and coordination of information within submittal with requirements of Work and Contract Documents.

D. Resubmittal Requirements:

1. Comply with submittal requirements.
2. Make corrections or changes in submittals required by ENGINEER. Resubmittals required until approved.
3. Identify on transmittal form if submittal is resubmission.
4. Shop Drawings and Product Data:
 - a. Revise initial drawings or data and resubmit as specified for initial submittal.
 - b. Indicate changes made other than those requested by ENGINEER.

E. Contractor shall be responsible for the distribution of reproductions of Shop Drawings and copies of product data which carry ENGINEER'S stamp.

F. ENGINEER'S Duties:

1. Review submittals.
2. Engineer will notify Contractor if submittals are deficient.
3. Engineer will not prepare a formal, written approval of submitted material.

1.05 TEST RESULTS AND CERTIFICATIONS

- A. Submit test results and certifications required in Specification sections.
- B. Submit test results upon completion of test or submittal of results from testing laboratory.

- C. Test results and certifications are submitted for review of conformance with specified requirements and information.

1.06 GUARANTEE, WARRANTIES, MAINTENANCE AGREEMENTS,
AND WORKMANSHIP BONDS

- A. NOT USED.

1.07 OPERATION AND MAINTENANCE (O&M) DATA

- A. Compile product data and related information appropriate for OWNER'S maintenance and operation of products furnished under Contract. Prepare O&M data as specified in this section.

- B. Manual Format: Prepare data in form of instructional manual for use by OWNER'S personnel.

1. Size: 8-1/2 in. by 11 in. or 11 in. by 17 in. folded, with standard 3-hole punching.
2. Text: Manufacturer's printed data, or neatly typewritten.
3. Drawings:
 - a. Provide reinforced punched binder tab, bind in with text.
 - b. Fold larger drawings to size of text pages and place in envelopes which are to be bound into manual. Place suitable identification on outside of each envelope.
4. Cover: Identify each submittal with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS."
 - a. List:
 - 1) Title of Project.
 - 2) Identity of Contractor.
 - 3) Identity of general subject matter covered in manual.
 - 4) Identity of section number as set forth in Contract Documents.
 - 5) Data of installation.
5. Binders:
 - a. Commercial quality binders with durable and cleanable plastic covers.

- C. Product Data:

1. Include only those sheets pertinent to specific product.
2. Annotate each sheet to:
 - a. Identify specific product or part installed.
 - b. Identify data applicable to installation.
 - c. Delete references to inapplicable information.
3. Provide table of contents.

1.08 ACTION ON SUBMITTALS

- A. NOT USED.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 SUBMITTAL REQUIREMENTS

- A. Provide complete copies of required submittals as follows.
 - 1. Construction Progress Schedule:
 - a. 2 copies of initial schedule.
 - b. 2 copies of each revision.
 - 2. Shop Drawings and Product Data: 2 copies.
 - 3. Test Results: 3 copies.
 - 4. Other Required Submittals:
 - a. 2 copies if required for review.
- B. Deliver required copies of submittals to ENGINEER at LJA Engineering, Inc., 3600 W. Sam Houston Pkwy S., Suite 600, Houston, Texas 77042. FAX # 713.953.5026

*** END OF SECTION ***

SECTION 01410

TESTING LABORATORY SERVICES

PART 1 GENERAL

1.01 PERFORMANCE REQUIREMENTS

- A. OWNER will employ services of independent testing laboratory to perform testing for work specified in following sections:
 - 1. Section 02210 - SITE GRADING
 - 2. Section S02317 - EXCAVATION AND BACKFILL FOR UTILITIES
 - 3. Section 02320 - UTILITY BACKFILL MATERIALS
 - 4. Section 433 - CEMENT STABILIZED SAND BEDDING AND BACKFILL MATERIAL
 - 5. Section 132 - EMBANKMENT
 - 6. Section 03300 - CAST-IN-PLACE CONCRETE

And any other specifications which require testing laboratory services. If re-testing is required due to the Contractor's failure to meet the requirements of the specifications, the Contractor shall be responsible for all costs associated with the re-testing by the Owner's testing laboratory.

- B. CONTRACTOR shall employ services of independent testing laboratory approved by OWNER to perform other testing as required that is beyond the responsibility of the Owner.
- C. CONTRACTOR shall cooperate with laboratory provided by OWNER to facilitate execution of laboratories required services.
- D. Employment of laboratory shall, in no way, relieve CONTRACTOR of obligations to perform work.
- E. Related Requirements in Other Parts of Contract Documents:
 - 1. The Contractor shall be responsible for any other inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities, not specified herein.

1.02 QUALIFICATION OF LABORATORY

- A. Meet basic requirements of ASTM E329.
- B. Authorized to operate in state in which Project is located.
- C. Testing Equipment:
 - 1. Calibrated at reasonable intervals by devices of accuracy traceable to either:
 - a. National Bureau of Standards.
 - b. Accepted values of natural physical constants.

1.03 **LABORATORY DUTIES**

- A. Cooperate with ENGINEER and CONTRACTOR; provide qualified personnel to perform Work after due Notice to Proceed.
- B. Perform specified inspections, secure samples, and test materials.
 - 1. Comply with specified standards.
 - 2. Ascertain compliance of materials with Contract Documents.
- C. Promptly notify ENGINEER of observed irregularities or deficiencies of Work, equipment or material.
- D. Promptly submit written report of each test and inspection; one copy each to ENGINEER, OWNER, material supplier, and CONTRACTOR, and one copy to record document file. Each report shall include following.
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Testing laboratory name, address, and telephone number.
 - 4. Name and signature of laboratory inspector.
 - 5. Date and time of sampling or inspection.
 - 6. Record of temperature and weather conditions if test performed in field.
 - 7. Date of test.
 - 8. Identification of product and Specification section.
 - 9. Location of sample or test in Project.
 - 10. Type of inspection or test.
 - 11. Results of tests and compliance with Contract Documents.
 - 12. Interpretation of test results, when requested by ENGINEER.
- E. Perform additional tests as required by ENGINEER.

1.04 **LIMITATIONS OF AUTHORITY OF TESTING LABORATORY**

- A. Laboratory is not authorized to:
 - 1. Release, revoke, alter or enlarge on requirements of Contract Documents.
 - 2. Approve or accept any portion of Work.
 - 3. Perform duties of CONTRACTOR.

1.05 **CONTRACTOR'S RESPONSIBILITIES**

- A. Cooperate with laboratory personnel and provide access to Work.
- B. Provide to laboratory preliminary design mix proposed to be used for concrete and other material mixes which require control by testing laboratory.
- C. Furnish copies of product test reports.
- D. Furnish incidental labor and facilities.
 - 1. Provide access to Work to be tested.
 - 2. Obtain and handle samples at Project site or at source of product to be tested.
 - 3. Facilitate inspections and tests.

TESTING LABORATORY SERVICES

4. Store and cure test samples.
- E. Notify laboratory and ENGINEER sufficiently in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.
 1. When tests or inspections cannot be performed after such notice, reimburse OWNER for laboratory personnel and travel expenses incurred due to CONTRACTOR'S negligence.
- F. Make arrangements with laboratory and pay for additional samples and tests required for CONTRACTOR'S convenience.
- G. Employ and pay for services of testing laboratory to perform additional inspections, sampling, and testing required when initial tests indicate Work does not comply with Contract Documents.

*** END OF SECTION ***

SECTION 01500

TEMPORARY CONSTRUCTION FACILITIES AND UTILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Water for construction.
2. Sanitary facilities.
3. Temporary sitework.
4. Security.

B. Measurement and Payment:

1. Consider work of this section incidental.

1.02 WATER FOR CONSTRUCTION

- A. Water may be available from dry hydrants located along the water's edge. Their functioning and capability must be confirmed with the Sabine River Authority (SRA). Secure permission from SRA, obtain necessary permits, and notify ENGINEER before obtaining water from fire hydrants. Permits may be required through SRA. Make arrangements and pay costs for temporary meters, connecting to hydrants, and water trucks required to transport water to point of use.
- B. Connection to hydrants shall prevent backflow to system.
- C. Use only special hydrant operating wrenches approved by the jurisdictional authority to open hydrants. Make certain hydrant valve is open full. If hydrants are damaged, CONTRACTOR shall be responsible and shall notify appropriate agency so damage can be repaired as quickly as possible. Fire hydrants shall be completely accessible to Fire Department.

1.03 SANITARY FACILITIES

- A. Provide temporary sanitary toilet facilities conforming to state and local health and sanitation regulations, in sufficient number for use by ENGINEER'S, CONTRACTOR'S, and Subcontractor's employees.
- B. Maintain in sanitary condition and properly supply with toilet paper.

1.04 TEMPORARY SITE WORK

- A. Construct and maintain temporary site roadways, OWNER'S existing roads, and public roads in clean, dust free, snow free, ice free, drive-able condition necessary to carry out construction operations.
- B. Maintain OWNER'S existing roads and public roads used during construction free from accumulations of dirt, mud and construction debris resulting from construction operations. Roads shall be considered "maintained" when material has been removed by a sweeper.

1.05 SECURITY

- A. Security will not be provided by OWNER.
- B. CONTRACTOR shall be responsible for loss or injury to persons or property where Work is involved, and shall provide security and take precautionary measures to protect CONTRACTOR'S interests, OWNER'S interests, and the public.

* * * END OF SECTION * * *

SECTION 01526

TRENCH SAFETY SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Trench safety system for the construction of trench excavations.
- B. Trench safety system for structural excavations which fall under provisions of State and Federal trench safety laws.

1.02 UNIT PRICES

- A. Measurement for trench safety systems used on trench excavations is on a linear foot basis for all trenches. No payment will be made for trench safety systems for structural excavations under this section. Include payment for trench safety system in applicable structure installation sections unless otherwise specified in the bid proposal.

1.03 DEFINITIONS

- A. A trench shall be defined as a narrow excavation (in relation to its depth) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet.
- B. The trench safety system requirements will apply to larger open excavations if the erection of structures or other installations limits the space between the excavation slope and these installations to dimensions equivalent of a trench as defined.
- C. Trench Safety Systems include but are not limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage.

1.04 SUBMITTALS

- A. Not used.

1.05 REGULATORY REQUIREMENTS

- A. Install and maintain trench safety systems in accordance with the detail specifications set out in the provision of Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended, including Final Rule, published in the Federal Register Vol. 54, No. 209 on Tuesday, October 31, 1989.
- B. Legislation that has been enacted by the Texas Legislature with regard to Trench Safety Systems, is hereby incorporated, by reference, into these specifications. Refer to Texas Health and Safety Code Ann.,756.021 (Vernon 1991).

1.06 INDEMNIFICATION

- A. CONTRACTOR shall indemnify and hold harmless the Engineer and Owner, its employees and agents, from any and all damages, costs (including, without limitation, legal fees, court costs, and the cost of investigation), judgments or claims by anyone for injury or death of persons resulting from the collapse or failure of trenches constructed under this Contract.
- B. CONTRACTOR acknowledges and agrees that this indemnity provision provides indemnity for the Engineer and Owner in case the Engineer and Owner is negligent either by act or omission in providing for trench safety, including, but not limited to safety program and design reviews, inspections, failures to issue stop work orders, and the hiring of the CONTRACTOR.

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install and maintain trench safety systems in accordance with provisions of OSHA 29CFR.
- B. Specially designed trench safety systems shall be installed in accordance with the trench safety drawings produced for the locations and conditions identified on the Drawings.
- C. A competent person, as identified in the CONTRACTOR's Trench Safety Program, shall verify that trench boxes and other premanufactured systems are certified for the actual installation conditions.

3.02 INSPECTION

- A. CONTRACTOR, or CONTRACTOR's independently retained consultant, shall make daily inspections of the trench safety systems to ensure that the installed systems and operations meet OSHA 29CFR and other personnel protection regulations requirements.
- B. If evidence of possible cave-ins or slides is apparent, CONTRACTOR shall immediately stop work in the trench and move personnel to safe locations until the necessary precautions have been taken by CONTRACTOR to safeguard personnel entering the trench.

3.03 FIELD QUALITY CONTROL

- A. CONTRACTOR shall verify specific applicability of the selected or specially designed trench safety systems to each field condition encountered on the project.

*** END OF SECTION ***

Section 01578

CONTROL OF GROUND AND SURFACE WATER

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Dewatering, depressurizing, draining, and maintaining trenches, shaft excavations, structural excavations and foundation beds in stable condition, and controlling ground water conditions for tunnel excavations.
- B. Protecting work against surface runoff and rising floodwaters.
- C. Trapping suspended sediment in the discharge from the surface and ground water control systems.

1.02 MEASUREMENT AND PAYMENT

A. UNIT PRICES

- 1. Measurement for control of ground water, if included in Document 00410 – Bid Form, will be on either a lump sum basis or a linear foot basis for continuous installations of wellpoints, eductor wells, or deep wells.
- 2. If not included in Document 00410 – Bid Form, include the cost to control ground water in unit price for work requiring such controls.
- 3. No separate payment will be made for control of surface water. Include cost to control surface water in unit price for work requiring controls.
- 4. Follow Section 01270 – Payment Procedures for unit price procedures.

- B. Stipulated Price (Lump Sum) Contract. If the Contract is a Stipulated Price Contract, include payment for work under this section in the total Stipulated Price.

1.03 REFERENCES

- A. ASTM D 698 - Standard Test Methods for Laboratory Compaction of Soils Using Standard Effort (12,400 ft-lbf/ft³ (600kN-m/m³))
- B. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA)
- C. Storm Water Management Handbook for Construction Activities prepared by City of Houston, Harris County and Harris County Flood Control District.

1.04 DEFINITIONS

- A. Ground water control system: system used to dewater and depressurize water-bearing soil layers.
 - 1. Dewatering: lowering the water table and intercepting seepage that would otherwise emerge from slopes or bottoms of excavations, or into tunnels and shafts; and disposing of removed water. Intent of dewatering is to increase stability of tunnel excavations and excavated slopes, prevent dislocation of material from slopes or bottoms of excavations, reduce lateral loads on sheeting and bracing, improve excavating and hauling characteristics of excavated material, prevent failure or heaving of bottom of excavations, and to provide suitable conditions for placement of backfill materials and construction of structures and other installations.
 - 2. Depressurization: includes reduction in piezometric pressure within strata not controlled by dewatering alone, necessary to prevent failure or heaving of excavation bottom or instability of tunnel excavations.
- B. Excavation drainage: includes keeping excavations free of surface and seepage water.
- C. Surface drainage: includes use of temporary drainage ditches and dikes and installation of temporary culverts and sump pumps with discharge lines necessary to protect Work from any source of surface water.
- D. Monitoring facilities for ground water control system: includes piezometers, monitoring wells and flow meters for observing and recording flow rates.

1.05 PERFORMANCE REQUIREMENTS

- A. Conduct subsurface investigations to identify groundwater conditions and to provide parameters for design, installation, and operation of groundwater control systems. Submit proposed method and spacing of readings for review prior to obtaining water level readings.
- B. Design ground water control system, compatible with requirements of Federal Regulations 29 CFR Part 1926 and Section 02260 - Trench Safety Systems to produce following results:
 - 1. Effectively reduce hydrostatic pressure affecting:
 - a. Excavations
 - b. Tunnel excavation, face stability or seepage into tunnels
 - 2. Develop substantially dry and stable subgrade for subsequent construction operations

3. Preclude damage to adjacent properties, buildings, structures, utilities, installed facilities and other work
 4. Prevent loss of fines, seepage, boils, quick condition, or softening of foundation strata
 5. Maintain stability of sides and bottom of excavations
- C. Provide ground water control systems that include single-stage or multiple-stage well point systems, eductor and ejector-type systems, deep wells, or combinations of these equipment types.
- D. Provide drainage of seepage water and surface water, as well as water from other sources entering excavation. Excavation drainage may include placement of drainage materials, crushed stone and filter fabric, together with sump pumping.
- E. Provide ditches, berms, pumps and other methods necessary to divert and drain surface water from excavation and other work areas.
- F. Locate ground water control and drainage systems so as not to interfere with utilities, construction operations, adjacent properties, or adjacent water wells.
- G. Assume sole responsibility for ground water control systems and for any loss or damage resulting from partial or complete failure of protective measures and settlement or resultant damage caused by ground water control operations. Modify ground water control systems or operations if they cause or threaten to cause damage to new construction, existing site improvements, adjacent property, adjacent water wells, or potentially contaminated areas. Repair damage caused by ground water control systems or resulting from failure of system to protect property as required.
- H. Install an adequate number of piezometers installed at proper locations and depths, necessary to provide meaningful observations of conditions affecting excavation, adjacent structures and water wells.
- I. Install environmental monitoring wells at proper locations and depths necessary to provide adequate observations of hydrostatic conditions and possible contaminant transport from contamination sources into work area or ground water control system.

1.06 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittals Procedures.
- B. Submit Ground Water and Surface Water Control Plan for review by Project Manager prior to start of excavation work. Include the following:
 1. Results of subsurface investigations and description of extent and characteristics of water bearing layers subject to ground water control

2. Names of equipment Suppliers and installation Subcontractors
 3. Description of proposed ground water control systems indicating arrangement, location, depth and capacities of system components, installation details and criteria and operation and maintenance procedures
 4. Description of proposed monitoring facilities indicating depths and locations of piezometers and monitoring wells, monitoring installation details and criteria, type of equipment and instrumentation with pertinent data and characteristics
 5. Description of proposed filters including types, sizes, capacities and manufacturer's application recommendations
 6. Design calculations demonstrating adequacy of proposed systems for intended applications. Define potential area of influence of ground water control operation near contaminated areas.
 7. Operating requirements, including piezometric control elevations for dewatering and depressurization
 8. Excavation drainage methods including typical drainage layers, sump pump application and other means
 9. Surface water control and drainage installations
 10. Proposed methods and locations for disposing of removed water
- C. Submit following records upon completion of initial installation:
1. Installation and development reports for well points, eductors, and deep wells
 2. Installation reports and baseline readings for piezometers and monitoring wells
 3. Baseline analytical test data of water from monitoring wells
 4. Initial flow rates
- D. Submit the following records weekly during control of ground and surface water operations:
1. Records of flow rates and piezometric elevations obtained during monitoring of dewatering and depressurization. Refer to Paragraph 3.02, Requirements for Eductor, Well Points, or Deep Wells.
 2. Maintenance records for ground water control installations, piezometers and monitoring wells

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Comply with requirements of agencies having jurisdiction.
- B. Comply with Texas Commission on Environmental Quality regulations and Texas Water Well Drillers Association for development, drilling, and abandonment of wells used in dewatering system.
- C. Obtain necessary permits from agencies with jurisdiction over use of groundwater and matters affecting well installation, water discharge, and use of existing storm drains and natural water sources. Since review and permitting process may be lengthy, take early action to obtain required approvals.
- D. Monitor ground water discharge for contamination while performing pumping in vicinity of potentially contaminated sites.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

- A. Select equipment and materials necessary to achieve desired results for dewatering. Selected equipment and materials are subject to review by Project Manager through submittals required in Paragraph 1.06, Submittals.
- B. Use experienced contractors, regularly engaged in ground water control system design, installation, and operation, to furnish and install and operate educators, well points, or deep wells, when needed
- C. Maintain equipment in good repair and operating condition.
- D. Keep sufficient standby equipment and materials available to ensure continuous operation, where required.
- E. Portable Sediment Tank System: Standard 55-gallon steel or plastic drums, free of hazardous material contamination.
 - 1. Shop or field fabricate tanks in series with main inlet pipe, inter-tank pipes and discharge pipes, using quantities sufficient to collect sediments from discharge water.

PART 3 EXECUTION

3.01 GROUND WATER CONTROL

- A. Perform necessary subsurface investigation to identify water bearing layers, piezometric

- pressures and soil parameters for design and installation of ground water control systems. Perform pump tests, if necessary to determine draw down characteristics. Present results in the Ground Water and Surface Water Control Plan. submittal
- B. Provide labor, material, equipment, techniques and methods to lower, control and handle ground water in manner compatible with construction methods and site conditions. Monitor effectiveness of installed system and its effect on adjacent property.
 - C. Install, operate, and maintain ground water control systems in accordance with the Ground Water and Surface Water Control Plan. Notify Project Manager in writing of changes made to accommodate field conditions and changes to Work. Provide revised drawings and calculations with notification.
 - D. Provide continuous system operation, including nights, weekends, and holidays. Arrange appropriate backup if electrical power is primary energy source for dewatering system.
 - E. Monitor operations to verify systems lower ground water piezometric levels at rate required to maintain dry excavation resulting in stable subgrade for subsequent construction operations.
 - F. Depressurize zones where hydrostatic pressures in confined water bearing layers exist below excavations to eliminate risk of uplift or other instability of excavation or installed works. Define allowable piezometric elevations in the Ground Water and Surface Water Control Plan.
 - G. Removal of ground water control installations.
 - 1. Remove pumping system components and piping when ground water control is no longer required.
 - 2. Remove piezometers, including piezometers installed during design phase investigations and left for Contractor's use, upon completion of testing, as required in accordance with Part 3 of applicable specification.
 - 3. Remove monitoring wells when directed by Project Manager.
 - 4. Grout abandoned well and piezometer holes. Fill piping that is not removed with cement-bentonite grout or cement-sandgrout.
 - H. During backfilling, maintain water level a minimum of 5 feet below prevailing level of backfill. Do not allow the water level to cause uplift pressures in excess of 80 percent of downward pressure produced by weight of structure or backfill in place. Do not allow water levels to rise into cement-stabilized sand until at least 48 hour after placement.
 - I. Provide uniform pipe diameter for each pipe drain run constructed for dewatering. Remove

pipe drains when no longer required. If pipe removal is impractical, grout connections at 50-foot intervals and fill pipe with cement- bentonite grout or cement-sand grout after removal from service.

- J. The extent of ground water control for structures with permanent perforated underground drainage systems may be reduced, for units designed to withstand hydrostatic uplift pressure. Provide a means to drain affected portions of underground systems, including standby equipment. Maintain drainage systems during construction operations.
- K. Remove systems upon completion of construction or when dewatering and control of surface or ground water is no longer required.
- L. Compact backfill to not less than 95 percent of maximum dry density in accordance with ASTM D 698.
- M. Foundation Slab: Maintain saturation line at least 3 feet below lowest elevations where concrete is to be placed. Drain foundations in areas where concrete is to be placed before placing reinforcing steel. Keep free from water for 3 days after concrete is placed.

3.02 REQUIREMENTS FOR EDUCTOR, WELL POINTS, OR DEEP WELLS

- A. For aboveground piping in ground water control system, include a 12-inch minimum length of clear, transparent piping between each eductor well or well point and discharge header to allow visual monitoring of discharge from each installation.
- B. Install sufficient piezometers or monitoring wells to show that trench or shaft excavations in water bearing materials are pre-drained prior to excavation. Provide separate piezometers for monitoring of dewatering and for monitoring of depressurization. Install piezometers and monitoring wells for tunneling as appropriate for selected method of work.
- C. Install piezometers or monitoring wells at least one week in advance of the start of associated excavation.
- D. Dewatering may be omitted for portions of under drains or other excavations, where auger borings and piezometers or monitoring wells show that soil is pre-drained by existing systems and that ground water control plan criteria are satisfied.
- E. Replace installations that produce noticeable amounts of sediments after development.
- F. Provide additional ground water control installations, or change method of control if, ground water control plan does not provide satisfactory results based on performance criteria defined by plan and by specifications. Submit revised plan according to Paragraph 1.06B.

3.03 SEDIMENT TRAPS

- A. Install sediment tank as shown on approved plan.

- B. Inspect daily and clean out tank when one-third of sediment tank is filled with sediment.

3.04 SEDIMENT SUMP PIT

- A. Install sediment sump pits as shown on approved plan.
- B. Construct standpipe by perforating 12 inch to 24-inch diameter corrugated metal or PVC pipe.
- C. Extend standpipe 12 inches to 18 inches above lip of pit.
- D. Convey discharge of water pumped from standpipe to sediment trapping device.
- E. Fill sites of sump pits, compact to density of surrounding soil and stabilize surface when construction is complete.

3.05 EXCAVATION DRAINAGE

- A. Use excavation drainage methods if well-drained conditions can be achieved. Excavation drainage may consist of layers of crushed stone and filter fabric, and sump pumping, in combination with sufficient ground water control wells to maintain stable excavation and backfill conditions.

3.06 MAINTENANCE AND OBSERVATION

- A. Conduct daily maintenance and observation of piezometers or monitoring wells while ground water control installations or excavation drainage is operating at the site, or water is seeping into tunnels, and maintain systems in good operating condition.
- B. Replace damaged and destroyed piezometers or monitoring wells with new piezometers or wells as necessary to meet observation schedules.
- C. Cut off piezometers or monitoring wells in excavation areas where piping is exposed, only as necessary to perform observation as excavation proceeds. Continue to maintain and make specified observations
- D. Remove and grout piezometers inside or outside of excavation area when ground water control operations are complete. Remove and grout monitoring wells when directed by Project Manager.

3.07 MONITORING AND RECORDING

- A. Monitor and record average flow rate of operation for each deep well, or for each wellpoint or eductor header used in dewatering system. Also, monitor and record water level and ground water recovery. Record observations daily until steady conditions are achieved

and twice weekly thereafter.

- B. Observe and record elevation of water level daily as long as ground water control system is in operation, and weekly thereafter until Work is completed or piezometers or wells are removed, except when Project Manager determines more frequent monitoring and recording are required. Comply with Project Manager's direction for increased monitoring and recording and take measures necessary to ensure effective dewatering for intended purpose.

3.08 SURFACE WATER CONTROL

- A. Intercept surface water and divert it away from excavations through use of dikes, ditches, curb walls, pipes, sumps or other approved means. Requirement includes temporary works required to protect adjoining properties from surface drainage caused by construction operations.
- B. Divert surface water and seepage water into sumps and pump it into drainage channels or storm drains, when approved by agencies having jurisdiction. Provide settling basins when required by agencies.

END OF SECTION

SECTION 02317

EXCAVATION AND BACKFILL FOR UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavation, trenching, foundation, embedment, and backfill for installation of utilities, including manholes and other pipeline structures.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No additional payment will be made for trench excavation, embedment and backfill under this Section. Include cost in the unit price for installed underground piping, sewer, conduit, or duct work.
 - 2. No separate or additional payment will be made for surface water control, ground water control, or for excavation drainage. Include in the unit price for the installed piping, sewer, conduit, or duct work.

1.03 DEFINITIONS

- A. Pipe Foundation: Suitable and stable native soils that are exposed at the trench subgrade after excavation to depth of bottom of the bedding as shown on the Drawings, or foundation backfill material placed and compacted in over-excavations.
- B. Pipe Bedding: The portion of trench backfill that extends vertically from top of foundation up to a level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.
- C. Haunching: The material placed on either side of pipe from top of bedding up to springline of pipe and horizontally from one trench sidewall to opposite sidewall.
- D. Initial Backfill: The portion of trench backfill that extends vertically from springline of pipe (top of haunching) up to a level line 12 inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.
- E. Pipe Embedment: The portion of trench backfill that consists of bedding, haunching and initial backfill.
- F. Trench Zone: The portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.
- G. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 - 2. Materials that cannot be compacted to required density due to either gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
 - 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- H. Suitable Material: Suitable soil materials are those meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement are considered suitable, unless otherwise indicated.
- I. Backfill: Suitable material meeting specified quality requirements, placed and compacted under controlled conditions.

- J. Ground Water Control Systems: Installations external to trench, such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom.
- K. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from trench excavation. Rain water and surface water accidentally entering trench shall be controlled and removed as a part of excavation drainage.
- L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using a drainage layer, as defined in ASTM D 2321, placed on the foundation beneath pipe bedding or thickened bedding layer of Class I material.
- M. Trench Conditions are defined with regard to the stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.
 - 1. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as a result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.
 - 2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.
 - a. Stable Trench with Seepage in Clayey Soils: Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.
 - b. Stable Wet Trench in Sandy Soils: Excavation drainage is provided in the embedment zone in combination with ground water control in predominately sandy or silty soils.
 - 3. Unstable Trench: Unstable trench conditions exist in the pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.
- N. Subtrench: Subtrench is a special case of benched excavation. Subtrench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of a subtrench depends upon trench stability and safety as determined by the Contractor.
- O. Trench Dam: A placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along the trench.
- P. Over-Excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Drawings, and backfilled with foundation backfill material.
- Q. Foundation Backfill Materials: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill to provide stable support for bedding. Foundation backfill materials may include concrete seal slabs.
- R. Trench Safety Systems include both protective systems and shoring systems as defined in Section 429 - Trench Safety System.

- S. Trench Shield (Trench Box): A portable worker safety structure moved along the trench as work proceeds, used as a protective system and designed to withstand forces imposed on it by cave-in, thereby protecting persons within the trench. Trench shields may be stacked if so designed or placed in a series depending on depth and length of excavation to be protected.
- T. Shoring System: A structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of the ground affecting adjacent installations or improvements.
- U. Special Shoring: A shoring system meeting special shoring as specified in Paragraph 1.08, Special Shoring Design Requirements, for locations identified on the Drawings.

1.04 REFERENCES

- A. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipe Lines.
- B. ASTM D 558 - Test Methods for Moisture-Density Relations of Soil Cement Mixtures.
- C. ASTM D 698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (304.8-mm) Drop.
- D. ASTM D 1556 - Test Method for Density in Place by the Sand-Cone Method.
- E. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
- F. ASTM D 2487 - Classification of Soils for Engineering Purposes.
- G. ASTM D 2922 - Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- H. ASTM D 3017 - Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- I. ASTM D 4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- J. TxDOT Tex-101-E - Preparation of Soil and Flexible Base Materials for Testing.
- K. TxDOT Tex-110-E - Determination of Particle Size Analysis of Soils.
- L. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).

1.05 SCHEDULING

- A. Schedule work so that pipe embedment can be completed on the same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.

1.06 SUBMITTALS

- A. Not Used.

1.07 TESTS

- A. Testing and analysis of backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by the Owner in accordance with requirements of Section 01410 - Testing Laboratory Services and as specified in this Section.
- B. Perform backfill material source qualification testing in accordance with requirements of Section 02320- Utility Backfill Materials.

1.08 SPECIAL SHORING DESIGN REQUIREMENTS

- A. Have special shoring designed or selected by the Contractor's Professional Engineer to provide support for the sides of the excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements and utilities. Special shoring may be a premanufactured system selected by the Contractor's Professional Engineer to meet the project site requirements based on the manufacturer's standard design.

PART 2 P R O D U C T S

2.01 EQUIPMENT

- A. Perform excavation with hydraulic excavator or other equipment suitable for achieving the requirements of this Section.
- B. Use only hand-operated tamping equipment until a minimum cover of 12 inches is obtained over pipes, conduits, and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.
- C. Use trench shields or other protective systems or shoring systems which are designed and operated to achieve placement and compaction of backfill directly against undisturbed native soil.
- D. Use special shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting requirements as specified in Paragraph 1.09, Shoring Design Requirements.

2.02 MATERIAL CLASSIFICATIONS

- A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02320 - Utility Backfill Materials.
- B. Concrete Backfill: Conform to requirements for Class B concrete as specified in Section 03300 – Cast-In-Place Concrete.
- C. Geotextile (Filter Fabric): Conform to requirements of Section 02621- Geotextile.
- D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.
- E. Timber Shoring Left in Place: Untreated oak.

PART 3 E X E C U T I O N

3.01 STANDARD PRACTICE

- A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D 2321, and as described in this Section. Where an apparent conflict occurs between the standard practice and the requirements of this Section, this Section governs.
- B. Install rigid pipe to conform with standard practice described in ASTM C 12, and as described in this Section. Where an apparent conflict occurs between the standard practice and the requirements of this Section, this Section governs.

3.02 PREPARATION

- A. Establish traffic control to conform with requirements of the Texas Manual of Uniform Traffic Control Devices. Maintain barricades and warning lights for streets and intersections affected by the Work, and is considered hazardous to traffic movements.
- B. Perform work to conform with applicable safety standards and regulations. Employ a trench safety system as specified in Section 429 - Trench Safety System.

- C. Immediately notify the agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from the Engineer and agency for any repairs or relocations, either temporary or permanent.
- D. Remove existing pavements and structures, including sidewalks and driveways, to conform with requirements of Section 104 – Remove Old Concrete and Section 495 - Remove Old Structures.
- E. Install and operate necessary dewatering and surface water control measures to conform with Section 01578 – Dewatering and Wet Sand Construction.
- F. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed.

3.03 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within the grading limits as designated on the Drawings.
- B. Protect and support above-grade and below-grade utilities which are to remain.
- C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities are indicated on the Drawings.
- D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches. Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, recompact, and pave those areas at no additional cost to Owner.

3.04 EXCAVATION

- A. Except as otherwise specified or shown on the Drawings, install underground utilities in open cut trenches with vertical sides.
- B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on the Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.
- C. Determine trench excavation widths using the following schedule as related to pipe outside diameter (O.D.). Maximum trench width shall be the minimum trench width plus 24 inches.

<u>Nominal Pipe Size, Inches</u>	<u>Minimum Trench Width, Inches</u>
Less than 36	O.D. + 24
36 to 42	O.D. + 36
Greater than 42	O.D. + 48

- D. Use sufficient trench width or benches above the embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from the surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and backfill, and other materials.
- E. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify the Engineer and obtain instructions before proceeding.
- F. Shoring of Trench Walls.
 - 1. Install Special Shoring in advance of trench excavation or simultaneously with the trench excavation, so that the soils within the full height of the trench excavation walls will remain laterally supported at all times.
 - 2. For all types of shoring, support trench walls in the pipe embedment zone throughout the installation. Provide trench wall supports sufficiently tight to prevent washing the trench wall soil out from behind the trench wall support.

3. Unless otherwise directed by the Engineer, leave sheeting driven into or below the pipe embedment zone in place to preclude loss of support of foundation and embedment materials. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and the trench wall in the vicinity of the pipe zone.
 4. Employ special methods for maintaining the integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.
 5. If sheeting or other shoring is used below top of the pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into the embedment zone shall be the equivalent of a 1-inch-thick steel plate. Fill voids left on removal of supports with compacted backfill material.
- G. Use of Trench Shields. When a trench shield (trench box) is used as a worker safety device, the following requirements apply:
1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to the trench sidewalls.
 2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor the degree of compaction reduced.
 3. When required, place, spread, and compact pipe foundation and bedding materials beneath the shield. For backfill above bedding, lift the shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.
 4. Maintain trench shield in position to allow sampling and testing to be performed in a safe manner.

3.05 HANDLING EXCAVATED MATERIALS

- A. Use only excavated materials which are suitable as defined in this Section and conforming with Section 02320 - Utility Backfill Materials. Place material suitable for backfilling in stockpiles at a distance from the trench to prevent slides or cave-ins.
- B. When required, provide additional backfill material conforming with requirements of Section 02320 - Utility Backfill Materials.
- C. Do not place stockpiles of excess excavated materials on streets and adjacent properties. Protect excess stockpiles for use on site.

3.06 GROUND WATER CONTROL

- A. Implement ground water control according to Section 01578 – Dewatering and Wet Sand Construction. Provide a stable trench to allow installation in accordance with the Specifications.

3.07 TRENCH FOUNDATION

- A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.
- B. Place trench dams in Class I foundations in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.08 PIPE EMBEDMENT, PLACEMENT, AND COMPACTION

- A. Immediately prior to placement of embedment materials, the bottoms and sidewalls of trenches shall be free of loose, sloughing, caving, or otherwise unsuitable soil.
- B. Place embedment including bedding, haunching, and initial backfill as shown on Drawings.

- C. For pipe installation, manually spread embedment materials around the pipe to provide uniform bearing and side support when compacted. Do not allow materials to free-fall from heights greater than 24 inches above top of pipe. Perform placement and compaction directly against the undisturbed soils in the trench sidewalls, or against sheeting which is to remain in place.
- D. Do not place trench shields or shoring within height of the embedment zone unless means to maintain the density of compacted embedment material are used. If moveable supports are used in embedment zone, lift the supports incrementally to allow placement and compaction of the material against undisturbed soil.
- E. Place geotextile to prevent particle migration from the in-situ soil into open-graded (Class I) embedment materials or drainage layers.
- F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.
- G. Place haunching material manually around the pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside the pipe with sand bags or other suitable means.
- H. Place electrical conduit, if used, directly on foundation without bedding.
- I. Shovel in-place and compact embedment material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.
- J. For water lines construction embedment, use bank run sand, concrete sand, gem sand, pea gravel, or crushed limestone as specified in Section 02320 - Utility Backfill Materials. For water lines adhere to the following subparagraph numbers 1 and 2; for utility installation other than water, adhere to numbers 3 and 4 below:
 - 1. Class I, II, and III Embedment Materials:
 - a. Maximum 6 inches compacted lift thickness.
 - b. Compact to achieve a minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
 - c. Moisture content to be within -2 percent to +2 percent of optimum as determined according to ASTM D 698, unless otherwise approved by Engineer.
 - 2. Cement Stabilized Sand:
 - a. Maximum 6 inches compacted thickness.
 - b. Compact to achieve a minimum of 95 percent of maximum dry density as determined according to ASTM D 698.
 - c. Moisture content to be on dry side of optimum as determined according to ASTM D 698 but sufficient for effective hydration.
 - 3. Class I embedment materials.
 - a. Maximum 6-inches compacted lift thickness.
 - b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed the pipe to meet the deflection test criteria.
 - c. Moisture content as determined by Contractor for effective compaction without softening the soil of trench bottom, foundation or trench walls.
 - 4. Class II embedment and cement stabilized sand.

- a. Maximum 6-inches compacted thickness.
- b. Compaction by methods determined by Contractor to achieve a minimum of 95 percent of the maximum dry density as determined according to ASTM D 698 for Class II materials and according to ASTM D 558 for cement stabilized materials.
- c. Moisture content of Class II materials within 2 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized sands on the dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.

K. Place trench dams in Class I embedments in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

3.09 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

- A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only the minimum length of trench open as necessary for construction.
- B. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave the sheeting in place. Cut off sheeting 1.5 feet or more above the crown of the pipe. Remove trench supports within 5 feet from the ground surface.
- C. For sewer pipes, use backfill materials described here as determined by trench limits. As trench zone backfill under pavement and within one foot back of curbs, use cement stabilized sand for pipes of all nominal sizes to level 12-inches below the pavement. Use select backfill for rigid pavement or flexible base material for asphalt pavements for 6-inch backfill directly under subgrade.
- D. For water lines, backfill in trench zone, including auger pits, with bank run sand, select fill, or random backfill material as specified in Section 02320 - Utility Backfill Materials.
- E. When shown on Drawings, a random backfill of suitable material may be used in trench zone for trench excavations outside pavements.
- F. Place trench zone backfill in lifts and compact by methods selected by the Contractor. Fully compact each lift before placement of the next lift.

1. Bank run sand.

- a. Maximum 9-inches compacted lift thickness.
- b. Compaction by vibratory equipment to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
- c. Moisture content within 2 percent of optimum determined according to ASTM D 698

2. Cement-stabilized sand.

- a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but not exceeding 24 inches.
- b. Compaction by vibratory equipment to a minimum of 95 percent of the maximum dry density determined according to ASTM D 558.
- c. Moisture content on the dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.

3. Select fill.
 - a. Maximum 6-inches compacted thickness.
 - b. Compaction by equipment providing tamping or kneading impact to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
 - c. Moisture content within 2 percent of optimum determined according to ASTM D 698.
- G. For trench excavations outside pavements, a random backfill of suitable material may be used in the trench zone.
 1. Fat clays (CH) may be used as trench zone backfill outside paved areas at the Contractor's option. If the required density is not achieved, the Contractor, at his option and at no additional cost to the Owner, may use lime stabilization to achieve compaction requirements or use a different suitable material.
 2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.
 3. Compact to a minimum of 90 percent of the maximum dry density determined according to ASTM D 698.
 4. Moisture content as necessary to achieve density.
- H. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.

3.10 MANHOLES, JUNCTION BOXES, AND OTHER PIPELINE STRUCTURES

- A. Meet the requirements of adjoining utility installations for backfill of pipeline structures, as shown on the Drawings.

3.11 FIELD QUALITY CONTROL

- A. Test for material source qualifications as defined in Section 02320 - Utility Backfill Materials.
- B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to Owner.
- C. Tests will be performed on a minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is a noticeable change in material gradation or plasticity.
- D. At least three tests for moisture-density relationships will be performed initially for backfill materials in accordance with ASTM D 698, and for cement-stabilized sand in accordance with ASTM D 558. Additional moisture-density relationship tests will be performed whenever there is a noticeable change in material gradation or plasticity.
- E. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at the following frequencies and conditions.
 1. A minimum of one test for every 20 cubic yards of compacted embedment and for every 50 cubic yards of compacted trench zone backfill material.
 2. A minimum of three density tests for each full shift of Work.
 3. Density tests will be distributed among the placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.

4. The number of tests will be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.
 5. Density tests may be performed at various depths below the fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
 6. Two verification tests will be performed adjacent to in-place tests showing density less than the acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.
 7. Recompact placement will be retested at the same frequency as the first test series, including verification tests.
- F. Recondition, re-compact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor's expense.
- G. Acceptability of crushed rock compaction will be determined by inspection.
- 3.12 DISPOSAL OF EXCESS MATERIAL
- A. Dispose of excess materials at no additional cost to the Owner or as specified in the plans.

END OF SECTION

SECTION 02320
UTILITY BACKFILL MATERIALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Material Classifications.
- B. Utility Backfill Materials:
 - Concrete sand
 - Gem sand
 - Pea gravel
 - Crushed stone
 - Crushed concrete
 - Bank run sand
 - Select backfill
 - Random backfill
- C. Material Handling and Quality Control Requirements.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No payment will be made for backfill material under this Section. Include payment in unit price for applicable utility installation.

1.03 DEFINITIONS

- A. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.
 - 2. Materials that cannot be compacted to the required density due to either gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, and stones greater than 4 inches in any dimension; debris, vegetation, and waste; or any other deleterious materials.
 - 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- B. Suitable Material: Suitable soil materials are the following:
 - 1. Those meeting specification requirements.
 - 2. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement.
- C. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for the structure foundation base. Foundation backfill materials may include concrete fill and seal slabs.
- D. Foundation Base: Crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. The foundation base provides a smooth, level working surface for the construction of the concrete foundation.
- E. Backfill Material: Classified soil material meeting specified quality requirements for the designated application as embedment or trench zone backfill.

- F. Embedment Material: Soil material placed under controlled conditions within the embedment zone extending vertically upward from top of foundation to an elevation 12 inches above top of pipe, and including pipe bedding, haunching, and initial backfill.
- G. Trench Zone Backfill: Classified soil material meeting specified quality requirements and placed under controlled conditions in the trench zone from top of embedment zone to base course in paved areas or to the surface grading material in unpaved areas.
- H. Foundation: Either suitable soil of the trench bottom, or material placed as backfill of over-excavation for removal and replacement of unsuitable or otherwise unstable soils.
- I. Source: A source selected by the Contractor for supply of embedment or trench zone backfill material. A selected source may be the project excavation, off-site borrow pits, commercial borrow pits, or sand and aggregate production or manufacturing plants.
- J. Refer to Section 02317 - Excavation and Backfill for Utilities for other definitions regarding utility installation by trench construction.

1.04 REFERENCES

- A. ASTM C 33 - Specification for Concrete Aggregate.
- B. ASTM C 40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
- C. ASTM C 123 - Test Method for Lightweight Pieces in Aggregate.
- D. ASTM C 131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- E. ASTM C 136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- F. ASTM C 142 - Test Method for Clay Lumps and Friable Particles in Aggregates.
- G. ASTM D 1140 - Test Method for Amount of Materials in Soils Finer Than No. 200 Sieve.
- H. ASTM D 2487 - Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- I. ASTM D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
- J. ASTM D 4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- K. ASTM D 4643 - Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
- L. TxDOT Tex-101-E - Preparation of Soil and Flexible Base Materials for Testing.
- M. TxDOT Tex-104-E - Test Method for Determination of Liquid Limit of Soils (Part 1)
- N. TxDOT Tex-106-E - Test Method - Methods of Calculating Plasticity Index of Soils.
- O. TxDOT Tex-110-E - Determination of Particle Size Analysis of Soils.

1.05 SUBMITTALS

- A. Not Used.

1.06 TESTS

- A. Perform tests of sources for backfill material in accordance with Paragraph 2.03B.
- B. Verification tests of backfill materials may be performed by the Owner in accordance with Section 01410 - Testing Laboratory Services and in accordance with Paragraph 3.03.

- C. Random fill obtained from the project excavation as source is exempt from prequalification requirements by Contractor but must be inspected by Owner testing lab for unacceptable materials based on ASTM D 2488.

PART 2 PRODUCTS

2.01 MATERIAL CLASSIFICATIONS

- A. Materials for backfill shall be classified for the purpose of quality control in accordance with the Unified Soil Classification Symbols as defined in ASTM D 2487. Material use and application is defined in utility installation specifications and Drawings either by class, as described in Paragraph 2.01B, or by product descriptions, as given in Paragraph 2.02.
- B. Class Designations Based on Laboratory Testing:
 - 1. Class I: Well-graded gravels and sands, gravel-sand mixtures, crushed well-graded rock, little or no fines (GW, SW):
 - a. Plasticity index: nonplastic.
 - b. Gradation: D_{60}/D_{10} - greater than 4 percent; amount passing No. 200 sieve - less than or equal to 5 percent.
 - 2. Class II: Poorly graded gravels and sands, silty gravels and sands, little to moderate fines: (GM,GP,SP,SM):
 - a. Plasticity index: nonplastic to 4.
 - b. Gradations:
 - 1) Gradation (GP, SP): amount passing No. 200 sieve - less than 5 percent.
 - 2) Gradation (GM, SM): amount passing No. 200 sieve - between 12 percent and 50 percent.
 - 3) Borderline gradations with dual classifications (e.g., SP-SM): amount passing No. 200 sieve - between 5 percent and 12 percent.
 - 3. Class III: Clayey gravels and sands, poorly graded mixtures of gravel, sand, silt, and clay (GC, SC, and dual classifications, e.g., SP-SC):
 - a. Plasticity index: greater than 7.
 - b. Gradation: amount passing No. 200 sieve - between 12 percent and 50 percent.
 - 4. Class IVA: Lean clays (CL).
 - a. Plasticity Indexes:
 - 1) Plasticity index: greater than 7, and above A line.
 - 2) Borderline plasticity with dual classifications (CL-ML): PI between 4 and 7.
 - b. Liquid limit: less than 50.
 - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
 - d. Inorganic.
 - 5. Class IVB: Fat clays (CH)
 - a. Plasticity index: above A line.
 - b. Liquid limit: 50 or greater.
 - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.

- d. Inorganic.
- 6. Use soils with dual class designation according to ASTM D 2487, and which are not defined above, according to the more restrictive class.

2.02 PRODUCT DESCRIPTIONS

- A. Soils classified as silt (ML), silty clay (CL-ML with PI of 4 to 7) elastic silt (MH), organic clay and organic silt (OL, OH), and organic matter (PT) are not acceptable as backfill materials. These soils may be used for site grading and restoration in unimproved areas as approved by the Engineer. Soils in Class IVB, fat clay (CH) may be used as backfill materials where allowed by the applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.
- B. Provide backfill material that is free of stones greater than 6 inches, free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to the following limits for deleterious materials:
 - 1. Clay lumps: Less than 0.5 percent for Class I, and less than 2.0 percent for Class II, when tested in accordance with ASTM C 142.
 - 2. Lightweight pieces: Less than 5 percent when tested in accordance with ASTM C 123.
 - 3. Organic impurities: No color darker than standard color when tested in accordance with ASTM C 40.
- C. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in the product specification, and approved by Engineer, provided that the physical property criteria are determined to be satisfactory by testing.
- D. Bank Run Sand: Durable bank run sand classified as SP, SW, or SM by the Unified Soil Classification System (ASTM D 2487) meeting the following requirements:
 - 1. Less than 15 percent passing the number 200 sieve when tested in accordance with ASTM D 1140. The amount of clay lumps or balls not exceeding 2 percent.
 - 2. Material passing the number 40 sieve shall meet the following requirements when tested in accordance with ASTM D 4318:
 - a. Liquid limit: not exceeding 25 percent.
 - b. Plasticity index: not exceeding 7.
- E. Concrete Sand: Natural sand, manufactured sand, or a combination of natural and manufactured sand conforming to the requirements of ASTM C 33 and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

- F. Gem Sand: Sand conforming to the requirements of ASTM C 33 for course aggregates specified for number 8 size and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
3/8"	95 to 100
No. 4	60 to 80
No. 8	15 to 40

- G. Pea Gravel: Durable particles composed of small, smooth, rounded stones or pebbles and graded within the following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
1/2"	100
3/8"	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

- H. Crushed Aggregates: Crushed aggregates consist of durable particles obtained from an approved source and meeting the following requirements:

1. Materials of one product delivered for the same construction activity from a single source.
2. Non-plastic fines.
3. Los Angeles abrasion test wear not exceeding 45 percent when tested in accordance with ASTM C 131.
4. Crushed aggregate shall have a minimum of 90 percent of the particles retained on the No. 4 sieve with 2 or more crushed faces as determined by Test Method Tex-460-A, Part I.
5. Crushed stone: Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from a naturally occurring single source. Uncrushed gravel are not acceptable materials for embedment where crushed stone is shown on the applicable utility embedment drawing details.
6. Crushed Concrete: Crushed concrete is an acceptable substitute for crushed stone as utility backfill. Gradation and quality control test requirements are the same as crushed stone. Provide crushed concrete produced from normal weight concrete of uniform quality; containing particles of aggregate and cement material, free from other substances such as asphalt, reinforcing steel fragments, soil, waste gypsum (calcium sulfate), or debris.

7. Gradations, as determined in accordance with Tex-110-E.

Sieve	Percent Passing by Weight for Pipe Embedment by Ranges of Nominal Pipes Sizes		
	>15"	15" - 8"	<8"
1"	95 - 100	100	-
3/4"	60 - 90	90 - 100	100
1/2"	25 - 60	-	90 - 100
3/8"	-	20 - 55	40 - 70
No. 4	0 - 5	0 - 10	0 - 15
No. 8	-	0 - 5	0 - 5

- I. Select Backfill: Class III clayey gravel or sand or Class IV lean clay with a plasticity index between 7 and 20 or clayey soils treated with lime in accordance with Section 02951 - Pavement Repair and Resurfacing, to meet plasticity criteria.
- J. Random Backfill: Any suitable soil or mixture of soils within Classes I, II, III and IV; or fat clay (CH) where allowed by the applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.
- K. Cement Stabilized Sand: Conform to requirements of Section 433 - Cement Stabilized Sand Bedding and Backfill Material.
- L. Concrete Backfill: Conform to Class B concrete as specified in Section 03300- Cast-In-Place Concrete.

2.03 MATERIAL TESTING

- A. Ensure that material selected, produced and delivered to the project meets applicable specifications and is of sufficient uniform properties to allow practical construction and quality control.
- B. Source or Supplier Qualification. Perform testing, or obtain representative tests by suppliers, for selection of material sources and products. Provide test results for a minimum of three samples for each source and material type. Tests samples of processed materials from current production representing material to be delivered. Tests shall verify that the materials meet specification requirements. Repeat qualification test procedures each time the source characteristic changes or there is a planned change in source location or supplier. Qualification tests shall include, as applicable:
 - 1. Gradation. Complete sieve analyses shall be reported regardless of the specified control sieves. The range of sieves shall be from the largest particle through the No. 200 sieve.
 - 2. Plasticity of material passing the No. 40 sieve.
 - 3. Los Angeles abrasion wear of material retained on the No. 4 sieve.
 - 4. Clay lumps.
 - 5. Lightweight pieces
 - 6. Organic impurities
- C. Production Testing. Provide reports to the Engineer from an independent testing laboratory that backfill materials to be placed in the Work meet applicable specification requirements.

- D. Assist the Engineer in obtaining material samples for verification testing at the source or at the production plant.

PART 3 EXECUTION

3.01 SOURCES

- A. Use of material encountered in the trench excavations is acceptable, provided applicable specification requirements are satisfied. If excavation material is not acceptable, provide from other approved source.
- B. Identify off-site sources for backfill materials at least 14 days ahead of intended use so that the Engineer may obtain samples for verification testing.
- C. Obtain approval for each material source by the Engineer before delivery is started. If sources previously approved do not produce uniform and satisfactory products, furnish materials from other approved sources. Materials may be subjected to inspection or additional verification testing after delivery. Materials which do not meet the requirements of the specifications will be rejected. Do not use material which, after approval, has become unsuitable for use due to segregation, mixing with other materials, or by contamination. Once a material is approved by the Engineer, expense for sampling and testing required to change to a different material will be credited to the Owner through a change order.
- D. Bank run sand, select backfill, and random backfill, if available in the project excavation, may be obtained by selective excavation and acceptance testing. Obtain additional quantities of these materials and other materials required to complete the work from off-site sources.
- E. The Owner does not represent or guarantee that any soil found in the excavation work will be suitable and acceptable as backfill material.

3.02 MATERIAL HANDLING

- A. When backfill material is obtained from either a commercial or non-commercial borrow pit, open the pit to expose the vertical faces of the various strata for identification and selection of approved material to be used. Excavate the selected material by vertical cuts extending through the exposed strata to achieve uniformity in the product.
- B. Establish temporary stockpile locations for practical material handling and control, and verification testing by the Engineer in advance of final placement. Obtain approval from landowner for storage of backfill material on adjacent private property.
- C. When stockpiling backfill material near the project site, use appropriate covers to eliminate blowing of materials into adjacent areas and prevent runoff containing sediments from entering the drainage system.
- D. Place stockpiles in layers to avoid segregation of processed materials. Load material by making successive vertical cuts through entire depth of stockpile.

3.03 FIELD QUALITY CONTROL

- A. Quality Control
 - 1. The Engineer may sample and test backfill at:
 - a. Sources including borrow pits, production plants and Contractor's designated off-site stockpiles.
 - b. On-site stockpiles.
 - c. Materials placed in the Work.
 - 2. The Engineer may resample material at any stage of work or location if changes in characteristics are apparent.

- B. Production Verification Testing: The Owner's testing laboratory will provide verification testing on backfill materials, as directed by the Engineer. Samples may be taken at the source or at the production plant, as applicable.

END OF SECTION

SECTION 02321
CEMENT STABILIZED SAND

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cement stabilized sand material.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. No payment will be made for cement stabilized sand under this Section. Include payment for cement stabilized sand in unit price for applicable utility or structure installation section.
2. If use of cement stabilized sand is allowed based on the Engineer's direction, the "Extra Cement Stabilized Sand" item will be paid on a cubic yard basis.

1.03 REFERENCES

- A. ASTM C 33 - Standard Specification for Concrete Aggregates (Fine Aggregate).
- B. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
- C. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.
- D. ASTM C 123 - Standard Test Method for Lightweight Pieces in Aggregate.
- E. ASTM C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
- F. ASTM C 150 - Specification for Portland Cement.
- G. ASTM D 558 - Standard Test Method for Moisture-Density Relations of Soil Cement-Mixtures.
- H. ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders.
- J. ASTM D 2487 - Standard Test Method for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- K. ASTM D 3665 - Practice for Random Sampling of Construction Materials.
- L. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.04 SUBMITTALS

- A. Not used.

1.05 DESIGN REQUIREMENTS

- A. Sand-cement mixture shall produce a minimum unconfined compressive strength of 100 pounds per square inch in 48 hours.
 1. Design will be based on strength specimens molded in accordance with ASTM D 558 at a moisture content within 3 percent of optimum and within 4 hours of batching.
 2. Determine minimum cement content from production data and statistical history. Mix shall contain not less than 1.1 sacks of cement per ton of dry sand.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement: Type I Portland cement conforming to ASTM C 150 (1.1 sacks per ton of mix for bedding of water, sanitary sewer, and storm pipes, 1.5 sacks per ton of mix for bedding of box culverts, and 2.5 sacks per cubic yard of mix for bedding of sanitary sewers at waterline crossings.).
- B. Sand: Clean, durable sand meeting grading requirements for fine aggregates of ASTM C 33, or requirements for bank run sand of Section 02320 - Utility Backfill Materials, and the following requirements:
 - 1. Classified as SW, SP, SW-SM, SP-SM, or SM by the United Soil Classification System of ASTM D 2487.
 - 2. Deleterious materials:
 - a. Clay lumps, ASTM C 142; less than 0.5 percent.
 - b. Lightweight pieces, ASTM C 123; less than 5.0 percent.
 - c. Organic impurities, ASTM C 40, color no darker than the standard color.
 - 3. Plasticity index of 4 or less when tested in accordance with ASTM D 4318.
- C. Water: Potable water, free of oils, acids, alkalies, organic matter, or other deleterious substances, meeting requirements of ASTM C 94.

2.02 MIXING MATERIALS

- A. Add required amount of water and mix thoroughly in a pugmill-type mixer.
- B. Stamp batch ticket at plant with time of loading. Material not placed and compacted within 4 hours after mixing shall be rejected.

2.03 MATERIAL QUALIFICATION

- A. Determine the target cement content of the material as follows:
 - 1. Obtain samples of sand-cement mixtures at the production facility representing a range of cement content consisting of at least three points.
 - 2. Complete the molding of samples within 4 hours after the addition of water.
 - 3. Perform strength tests (average of two specimens) at 48 hours and 7 days.
 - 4. Perform cement content tests on each sample.
 - 5. Perform moisture content tests on each sample.
 - 6. Plot average 48-hour strength vs. cement content
 - 7. Record scale calibration date, sample date, sample time, molding time, cement feed dial settings, and silo pressure (if applicable).
- B. Test the raw sand for the following properties at the point of entry into the pug-mill:
 - 1. Gradation.
 - 2. Plasticity index.
 - 3. Organic impurities.
 - 4. Clay lumps and friable particles.

5. Lightweight pieces.
 6. Moisture content.
 7. Classification.
- C. Present the data obtained in a format similar to that provided in the sample data form attached to this Section.
- D. The target content may be adjusted if statistical history so indicates. For determination of minimum product performance use the formula:

$$f'_c + 1/2 \text{ standard deviation}$$

PART 3 EXECUTION

3.01 PLACING

- A. Place sand-cement mixture in a maximum 12-inch-thick loose lift and compact to 95 percent of ASTM D 558, unless otherwise specified. Refer to related specifications for thickness of lifts in other applications. The target moisture content during compaction is ± 2 percent of optimum. Perform and complete compaction of sand-cement mixture within 4 hours after addition of water to mix at the plant.
- B. Do not place or compact sand-cement mixture in standing or free water.

3.02 FIELD QUALITY CONTROL

- A. Testing will be performed under provisions of Section 01410 - Testing Laboratory Services.
- B. Samples of delivered product will be taken in the field at point of delivery for testing in accordance with ASTM D 3665.
- C. Four specimens shall be prepared and molded (for each sample obtained) in accordance with ASTM D 558, Method A, without adjusting the moisture content. Samples will be molded at approximately the same time the material is being used, but no later than 4 hours after water is added to mix.
- D. After molding, specimens will be removed from the molds and sealed in a plastic bag or similar material to minimize moisture loss. Specimens will be cured at a room temperature between 60 and 80 degrees F until ready for testing.
- E. Specimens will be tested for compressive strength in accordance with ASTM D 1633, Method A. Two specimens will be tested at 48 hours plus or minus 2 hours and two specimens will be tested at 7 days plus or minus 4 hours.
- F. A strength test will be the average of the strengths of two specimens molded from the same sample of material and tested at the same age. The average daily strength will be the average of the strengths of all specimens molded during one day's production and tested at the same age.
- G. Precision and Bias: Test results shall meet the recommended guideline for precision in ASTM D 1633 Section 9.
- H. Reporting: Test reports shall contain, as a minimum, the following information:
1. Supplier and plant number
 2. Time material was batched
 3. Time material was sampled
 4. Test age (exact hours)
 5. Average 48-hour strength
 6. Average 7-day strength

7. Specification section number
8. Compliance / non-compliance
9. Mixture identification
10. Truck and ticket numbers
11. The time of molding
12. Moisture content at time of molding
13. Required strength
14. Test method designations
15. Compressive strength data as required by ASTM D 1633

3.03 ACCEPTANCE

- A. The strength level of the material will be considered satisfactory if:
 1. The average 48-hour strength is greater than 100 psi with no individual strength test below 70 psi, and
 2. All 7-day individual strength tests exceed 100 psi.
- B. The material will be considered unacceptable and subject to removal and replacement at the Contractor's expense if any individual strength test has a 7-day strength less than 100 psi.
- C. The testing laboratory shall notify the Contractor, Engineer, and material supplier by facsimile of all tests indicating results falling below specified strength requirements.

END OF SECTION

SECTION 02621

GEOTEXTILE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Geotextile, also called filter fabric in applications such as pipe embedment wrap, around the exterior of a tunnel liner, around the foundations of pipeline structures, and slope stabilization.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.
 - 1. No separate payment will be made for work performed under this Section. Include cost of such work in unit prices for work requiring geotextile.

1.03 REFERENCES

- A. AASHTO M 288 - Standard Specification for Geotextiles.
- B. ASTM D 3776 - Standard Test Methods for Mass per Unit Area (Weight) of Woven Fabric.
- C. ASTM D 3786 - Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Non-Woven Fabrics - Diaphragm Bursting Tester Method.
- D. ASTM D 3787 - Test Methods for Bursting Strength of Knitted Good Constant Rate of Traverse (CRT Ball Burst Test).
- E. ASTM D 4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- F. ASTM D 4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
- G. ASTM D 4632 - Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).
- H. ASTM D 4751 - Standard Test Method for Determining Apparent Opening Size of Geotextiles.
- I. ASTM D 4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
- J. Corps of Engineers, COE CW - 02215 - Geotextiles Used As Filters.

1.04 SUBMITTALS

Not Used.

PART 2 PRODUCTS

2.01 GEOTEXTILE

- A. Provide a geotextile (filter fabric) designed for use in geotechnical applications. The filter fabric shall provide a permeable layer or media while retaining the soil matrix.
- B. Use fabric which meets the physical requirements for Class A subsurface drainage installation conditions as defined in AASHTO M 288 and as specified in Paragraph 2.02, Properties.

2.02 PROPERTIES

- A. Material: Nonwoven, non-biodegradable, fabric consisting only of continuous chain polymer filaments or yarns, at least 85 percent by weight polyolefins, polyesters or polyamide, formed into a dimensionally stable network.
- B. Chemical Resistance: Inert to commonly encountered chemicals and hydrocarbons over a pH range of 3 to 12.
- C. Physical Resistance: Resistant to mildew and rot, ultraviolet light exposure, insects and rodents.
- D. Minimum Test Values:

<u>Property</u>	<u>Value (Min.)</u>	<u>Test Method</u>
Grab Strength	180 lbs	ASTM D 4632
Trapezoidal Tear Strength	50 lbs	ASTM D 4533
Puncture Strength	80 lbs	ASTM D 4833
Mullen Burst Strength	290 psi	ASTM D 3786
Apparent Opening Size ⁽¹⁾	0.25 mm	ASTM D 4751
Permittivity (sec ⁻¹)	0.2	ASTM D 4491

(1) Maximum average roll value.

PART 3 EXECUTION

3.01 LINE WORK

- A. The use of the geotextile with backfill for utilities shall conform to Section 02317 - Excavation and Backfill for Utilities.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 REFERENCES

A. American Concrete Institute (ACI):

1. 117-90 - Standard Specification for Tolerances for Concrete Construction and Materials.
2. 318-92 - Building Code Requirements for Reinforced Concrete.
3. SP-66-88 - ACI Detailing Manual.

B. American Society for Testing and Materials (ASTM):

1. A185 REV A-90 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
2. A370-92 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
3. A615 REV A-92 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
4. A706 REV B-92 - Standard Specification For Low-Alloy Steel Deformed Bars for Concrete Reinforcement.

C. American Welding Society (AWS):

1. D1.4-92 - Structural Welding Code Reinforcing Steel.

D. Concrete Reinforcing Steel Institute (CRSI):

1. Placing Reinforcing Bars.

1.02 MEASUREMENT AND PAYMENT

- A. No separate payment for concrete reinforcement include in cost of applicable item.

1.03 SUBMITTALS

A. Shop Drawings:

1. Conform to ACI SP-66 showing bending diagrams; assembly diagrams; location diagrams; splicing and laps of bars, shapes, and dimensions; and details for bar reinforcing, stirrup spacing, accessories, and openings.
2. Coordinate bar splicing and placement with CONTRACTOR'S concrete placing schedule and joint locations.
3. Unless otherwise approved by ENGINEER, each submittal shall include all reinforcement for individual structures they pertain to.

B. Product Data:

1. Dowel bar splicer system and reinforcing bar splicer laboratory reports and manufacturer's product data.

C. Mill Certifications:

1. Submit for each lot of reinforcing bars used per ASTM A615 and A706.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store reinforcing steel on supports above ground; cover and keep clean.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Reinforcing Bars:

1. Deformed bars conforming to ASTM A615, Grade 60.

B. Smooth Dowels: Plain bars conforming to ASTM A615, Grade 60.

C. Welded Wire Fabric (WWF): ASTM A185.

1. Unless other size noted, whenever welded wire fabric is called for, it shall be 6 x 6 - W2.9 x W2.9.
2. Provide welded wire fabric heavier than W2.9 in flat sheets.

D. Reinforcing Supports:

1. Exterior exposed surfaces, surfaces in contact with earth or liquid, and interior exposed surfaces in humid areas shall have all plastic or stainless steel supports.
2. Interior exposed surfaces in dry areas shall have all plastic, stainless steel, or plastic tipped steel supports.

E. Reinforcing Tension Bar Splicers:

1. Manufacturers:

- a. Cadweld or Lenton rebar splicers by Erico Products, Inc.
- b. Dayton Barsplice, Inc.
- c. Or equal.

2. Develop minimum 125% of yield capacity of bars spliced in tension when tested as assembly in accordance with ASTM A370 and A615.

F. Dowel Bar Splicer Systems:

1. Manufacturers:

- a. DB-SAE splicer system by Richmond Screw Anchor Company, Inc.
- b. C2D rebar flange coupler by Williams Form Engineering Corporation.
- c. Lenton Form Saver by Erico Products, Inc.
- d. Or equal.

2. Develop minimum 125% yield capacity of dowels when tested as assembly in accordance with ASTM A370 and A615.

G. Lap Splice Connection Systems:

1. Manufacturers:

- a. Systems Intersect by Dayton Superior.
- b. Stabox by Rebar Coupler Box, Inc.
- c. Or equal.

2. Prefabricated plastic or metal boxes containing prefabricated, rebendable quality anchorage and lap splice reinforcement conforming to ACI 318 and ASTM 615 or A706.

2.02 FABRICATION

- A. Fabricate to schedules and details on Drawings and in accordance with ACI 318.

PART 3 EXECUTION

3.01 PLACEMENT

- A. Placement of reinforcing steel shall be approved by ENGINEER before covered with concrete.
- B. Correct displacement of reinforcement prior to and during concrete pouring operations. Maintain clear cover as noted on Drawings. Tolerances shall be in accordance with ACI 117 and ACI 318, unless noted otherwise.
- C. Support reinforcing steel in accordance with CRSI "Placing Reinforcing Bars" with maximum spacing of 4 ft-0 in.
- D. Tie reinforcing steel at intersections in accordance with CRSI "Placing Reinforcing Bars."
 - 1. Maximum Tie Spacing for Footings, Walls, and Columns: Every third intersection or 3 ft-0 in.
 - 2. Maximum Spacing for Slabs and Other Work: Every fourth intersection or 3 ft-0 in.
 - 3. Tie each dowel in-place.
- E. Locate reinforcing to avoid interference with items drilled in later, such as concrete anchors.
- F. Reinforcement shall be continuous through construction joints.
- G. Reinforcement may be spliced at construction joints provided that the entire lap is placed within only 1 pour.
- H. Extend welded wire fabric to within 2 in. of edges of slab or section. Lap sheets at least 12 in. or 2-wire spaces, whichever is greater, at ends and edges and wire together. Stagger end laps.

CONCRETE REINFORCEMENT

- I. Unless shown otherwise on Drawings, place welded wire fabric between upper third point and mid-point of slab. Welded wire fabric placement on subgrade and pulling up during concrete placement not allowed.
- J. Use concrete brick for supporting bottom mat reinforcing on grade. Use bolsters or chairs supported on concrete brick or tied to bottom mat for supporting upper reinforcing mat on grade. Use bolsters or chairs for supporting reinforcing on mud slabs, metal deck, and forming.
- K. Dowel bar splicer systems may be substituted for dowels at CONTRACTOR'S option when approved by ENGINEER.
- L. Reinforcing bar splicers may be substituted for lapped splices at CONTRACTOR'S option when approved by ENGINEER. Stagger splices.
- M. Lap splice connection systems may be substituted for dowels at CONTRACTOR option when approved by ENGINEER.
 - 1. Use limited to non-stressed, redundant structurally non-critical areas, at wall-to-wall and/or wall-to-slab construction joints.
 - 2. Use limited to size Nos. 3, 4, and 5 reinforcement bars.
 - 3. Reinforcement must be bent about preferred weak axis.
 - 4. Reinforcement shall be field straightened in accordance with manufacturer's written recommendations at temperature above 32 degrees Fahrenheit.
 - 5. Reinforcement may be rebent only once.
 - 6. Key size and lap length shall be as detailed.
- N. Do not field bend bars, including bars partially embedded in concrete unless indicated.
- O. Do not place bars having kinks and bends other than shown on approved Shop Drawings.
- P. Reinforcement shall be clean and free from loose mill scale, dirt, grease, oil, form release agent, dried concrete or any material reducing bond with concrete.

*** END OF SECTION ***

SECTION 02210

SITE GRADING

PART 1 GENERAL

1.01 SUMMARY

Includes final site grading for embankments, site drainage, and landscaping.

1.02 MEASUREMENT AND PAYMENT

Site grading includes excavation or embankment activities (+ / -0.5 foot depth) required to complete final grading of lots and reserves. Payment for lot grading, including all final grading of lots and reserves, is on a lump sum basis.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM D1140-54 - Standard Test Method for Amount of Material in Soils Finer than the No. 200 (75-um) Sieve.
2. ASTM D1557-78 - Standard Test Methods for Moisture Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-inches (457-mm) Drop.
3. ASTM D4253-83 - Standard Test Methods for Maximum Index Density of Soils Using a Vibratory Table.
4. ASTM D4318-84 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.04 DEFINITIONS

- A. Influence Zone Under Foundations, Pavements, or Sidewalks: Area below foundation or pavement and sidewalk subbase bounded by 1 horizontal to 2 vertical slope extending outward from 1-foot beyond outer edge of foundation, pavement or sidewalk.
- B. Influence Zone Around Piping or Electrical Ducts: Area below limits bounded by line 12 inches above pipe or duct and by 1 horizontal to 2 vertical slope extending outward from that line 1-foot beyond outer edge of pipe or duct.
- C. Unsuitable Material: Topsoil, peat, organic soils, and materials containing slag, cinders, foundry sand, debris, and rubble or soil with less than required bearing capacity as determined by ENGINEER.

1.05 QUALITY ASSURANCE

- A. Testing will be provided by OWNER in accordance with Section 01410 – Testing Laboratory Services.

1.06 PROJECT/SITE CONDITIONS

- A. Notify corporations, companies, individuals or authorities owning above or below ground conduits, wires, pipes or other utilities running to property or encountered during grading operations.
- B. Cap or remove and relocate services in accordance with instructions by owners of said services.
- C. Protect, support, and maintain conduits, wires, pipes or other utilities that are to remain in accordance with requirements of owners of said services.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Conform to requirements of Sections 02316, 02317, 02320, and 02330.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine surfaces to receive fill to determine existence of areas loosened by frost action, softened by flooding or weather or of unsuitable materials.

3.02 PREPARATION

- A. Prepare site as specified in Section 02100 – Site Preparation.
- B. Fill settled areas where excavations or trenches were backfilled and holes made by demolition, tree removal, and site preparation work.
- C. Natural soils or compacted fill softened by frost, flooding or weather shall be removed, replaced, and compacted.
- D. Remove unsuitable material from under walks, parking, and driveway areas.
- E. Proof roll areas to receive fill material to detect soft or loose zones prior to placing fill. Remove and replace soft or loose zones.
- F. Keep construction site free-draining.
- G. Plow, step, or bench slopes steeper than 1 vertical to 4 horizontal.
- H. Disc level surfaces.

- I. Grading within influence zone of existing or future structures or piping and electrical ducts shall be in accordance with Section 02316 and 02317.
- 3.03 FILL USAGE
- A. Controlled or Structural: Within influence zone under pavements or sidewalks.
- 3.04 PLACING FILL
- A. Conform to requirements of Sections 02320 and 02330.
- 3.05 FIELD QUALITY CONTROL
- A. Final Grading Tolerances:
 - 1. Grade to within ± 0.1 foot of proposed finished grade in areas to receive topsoil, unless new grade is less than 4 inches above existing grade. Grade to bottom of base course in areas to receive paving or riprap. Maximum allowable variation from design elevation is 1 inch in 10 feet. Degree of finish shall be ordinarily obtainable from either blade-grader or scraper operations, except as otherwise specified.
 - 2. Final grading areas, including excavated and filled sections and adjacent transition areas shall be reasonably smooth, compacted, and free from irregular surface changes.
 - B. Degree of Compaction: ASTM D698 and ASTM D2922.
 - C. Moisture Content of Controlled Fill: Within 2% of optimum when placed and compacted.
- 3.06 ADJUSTMENT AND CLEANING
- A. Excess Material:
 - 1. Remove material not required by OWNER from site at CONTRACTOR'S expense.
 - B. Stockpile material suitable for backfill where indicated on Drawings or designated by ENGINEER. Place no fill where trenches for sewers, water lines or other utilities will be located.
 - C. Place material not suitable for backfilling or site grading and unsuitable materials in designated spoil areas and grade to drain. If no spoil areas are provided on-site, remove excess material from site.
 - D. Final grade areas within grading lines and areas which are disturbed to achieve lines and grades indicated on Drawings, with allowance for thickness of pavements, sidewalks, and topsoil.

*** END OF SECTION ***

SECTION 02506

POLYVINYL CHLORIDE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Polyvinyl chloride pressure pipe for water distribution in nominal diameters 4 inches through 16 inches.
- B. Polyvinyl chloride sewer pipe for gravity sanitary sewers in nominal diameters 4 inches through 48 inches.
- C. Polyvinyl chloride pressure pipe for gravity sanitary sewers and force mains in nominal diameters 4 inches through 36 inches.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

- 1. No separate payment will be made for PVC pipe under this section. Include cost in unit price for work included as specified in the following sections:
 - a. Section 02511 - Water Mains
 - b. Section 02531 - Gravity Sanitary Sewers
 - c. Section 02532 - Sanitary Sewer Force Mains

1.03 REFERENCES

- A. ANSI A21.5 (AWWA C 105) - Polyethylene Encasement for Ductile-Iron Piping for Water and Other Liquids.
- B. ANSI A21.10 (AWWA C 110) - Ductile-Iron and Gray-Iron Fittings, 3 inches through 48 inches for Water and Other Liquids.
- C. ANSI A21.11 (AWWA C 111) - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- D. ASTM D 1248 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
- E. ASTM D 1784 - Standard Specification for Rigid Polyvinyl Chloride Compound and Chlorinated Polyvinyl Chloride Compounds.
- F. ASTM D 2241 - Standard Specification for Polyvinyl Chloride Plastic Pipe (SDR-PR).
- G. ASTM D 2321 - Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- H. ASTM D 2444 - Test Method for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).
- I. ASTM D 2680 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Polyvinyl Chloride Composite Sewer Piping.
- J. ASTM D 3034 - Specification for Type PSM Polyvinyl Chloride Sewer Pipe and Fittings.

- K. ASTM D 3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- L. ASTM D 3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
- M. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- N. ASTM F 679 - Specification for Polyvinyl Chloride Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
- O. ASTM F 794 - Specification for Polyvinyl Chloride Large-Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- P. ASTM F 949 - Specification for Polyvinyl Chloride Corrugated Sewer Pipe with a Smooth Interior and Fittings.
- Q. AWWA C 900 - Polyvinyl Chloride Pressure Pipe, 4 Inches Through 12 Inches for Water Distribution.
- R. AWWA C 905 - Polyvinyl Chloride Water Transmission Pipe, Nominal Diameters 14 Inches Through 36 Inches.
- S. PPI TR3 - Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
- T. UNI-B-11 - Recommended Standard Specification for Polyvinyl Chloride Water Transmission Pipe (Nominal Diameters 14 Inches through 36 Inches).
- U. UNI-B-13 - Recommended Standard Performance Specification for Joint Restraint Devices for Use with Polyvinyl Chloride Pipe.

1.04 SUBMITTALS

- A. Conform to requirements of Section 01300 - Submittals.
- B. Provide proposed pipe manufacturer's specifications.

1.05 QUALITY CONTROL

- A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C 900 or AWWA C 905 for pressure pipe applications, or the appropriate ASTM standard specified for gravity sewer pipe.
- B. Submit manufacturer's certification that PVC pressure pipe has been hydrostatically tested at the factory in accordance with AWWA C 900 or AWWA C 905 and this Section.
- C. When foreign manufactured material is proposed for use, have material tested for conformance to applicable ASTM requirements by certified independent testing laboratory located in United States. Certification from any other source is not acceptable. Furnish copies of test reports to Engineer for review. Cost of testing shall be borne by Contractor.

PART 2 PRODUCTS

2.01 MATERIAL

- A. Use PVC compounds in the manufacture of pipe that contain no ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic.

- B. Furnish PVC pressure pipe manufactured from Class 12454-A or Class 12454-B virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for a rating of 4000 psi for water at 73.4 degrees F per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage.
- C. For PVC pressure pipe used for water mains, provide self-extinguishing PVC pipe that bears Underwriters' Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.
- D. Gaskets:
 - 1. Gaskets shall meet the requirements of ASTM F 477. Use elastomeric factory-installed gaskets to make joints flexible and watertight.
 - 2. Pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed sewer, shall have the following gasket materials for the noted contaminants.

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other contaminants	As recommended by the pipe manufacturer

3. Do not use PVC gasket material for water mains in potentially contaminated areas.

- E. Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.
- F. PVC pipe for water service shall bear National Sanitation Foundation Seal of Approval (NSF-PW).

2.02 WATER SERVICE PIPE

- A. Pipe 4–inch: AWWA C900; Class 305; DR 14; nominal 20-foot lengths; cast-iron equivalent outside diameter.
- B. Pipe 6-inch through 12-inch: AWWA C 900, Class 235, DR 18; nominal 20-foot lengths; cast-iron equivalent outside diameters.
- C. Pipe greater than 12 inches: AWWA C 905; Class 235; DR 18; nominal 20-foot lengths; cast-iron equivalent outside diameter.
- D. For large-diameter water mains, provide pipe manufactured by J-M Manufacturing Company, North American, Diamond Plastics Corporation, or I-Pex, or approved equal.
- E. Joints: ASTM D 3139; push-on type joints in integral bell or separate sleeve couplings. Do not use socket type or solvent weld type joints.
- F. Make curves and bends by deflecting the joints. Do not exceed maximum deflection recommended by the pipe manufacturer. Submit details of other methods of providing curves and bends for review by Engineer.
- G. Hydrostatic Test: AWWA C 900, AWWA C 905, ANSI A 21.10 (AWWA C 110); at point of manufacture; submit manufacturer's written certification.

2.03 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

- A. Bends and Fittings: ANSI A 21.10, ductile iron; ANSI A 21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating.
- B. Coatings and Linings: Conform to requirements of Section 02501 - Ductile-Iron Pipe and Fittings.

2.04 GRAVITY SANITARY SEWER PIPE

- A. PVC gravity sanitary sewer pipe shall be in accordance with the provisions in the following table:

WALL CONSTRUCTION	MANUFACTURER	USAGE	ASTM/AWWA DESIGNATION	SDR (MAX.)/ PRESSURE RATING (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe CertainTeed Can-Tex Carlton Diamond or Pre-approved Equal	Gravity Sanitary Sewer, Less than 20 foot depth	ASTM D2241	SDR 26 / PR 160	6" to 18"
		Gravity Sanitary Sewer, Greater or equal to 20 foot depth	AWWA C900	DR 18 / Class 235	6" to 12"
		Gravity Sanitary Sewer, Greater or equal to 20 foot depth	AWWA C905	DR 18	14" to 36"

- B. Joints: Spigot and integral wall section bell with solid cross section elastomeric or rubber ring gasket conforming to requirements of ASTM D 3139 and ASTM F 477. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. The manufacturer shall test a sample from each batch conforming to requirements ASTM D 2444.
- C. Bends and Fittings: ANSI A 21.10, ductile iron; ANSI A 21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating.
- D. Coatings and Linings: Conform to requirements of Section 02501 – Ductile Iron Pipe and Fittings.

2.05 SANITARY SEWER FORCE MAIN PIPE

- A. Provide PVC pressure pipe conforming to the requirements for water service pipe, and conforming to the minimum working pressure rating specified in Section 02532 - Sanitary Sewer Force Mains.
- B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting the requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use EBAA Iron Series 2000PV, Uniflange Series 1350 restrainer, or equal joint restraint device conforming to UNI-B-13, for PVC pipe 12-inch diameter and less.
- C. Fittings: Provide ductile iron fittings as per Paragraph 2.03, except furnish fittings with one of the following internal linings:
 - 1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to the interior surface of the fitting, as manufactured by American Cast Iron Pipe "Polybond", or U.S. Pipe "Polyline".

2. Nominal 40 mils (35 mils minimum) polyurethane, Corro-pipe II by Madison Chemicals, Inc.
 3. Nominal 40 mils (35 mils minimum) ceramic epoxy, Protecto 401 by Enduron Protective Coatings.
- D. Exterior Protection: Provide polyethylene wrapping of ductile iron fittings as required by Section 02528 - Polyethylene Wrap.
- E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with Paragraph 2.02G.
- F. Manufacturers: Approved manufacturers of pressure rated, solid wall PVC pipe for sanitary sewer force mains are:
1. J-M Manufacturing Company, Inc.
 2. CertainTeed Corporation
 3. Diamond Plastics Corporation
 4. Carlon Company
 5. or Pre-approved Equal

PART 3 EXECUTION

3.01 PROTECTION

- A. Store pipe under cover out of direct sunlight and protect from excessive heat or harmful chemicals in accordance with the manufacturer's recommendations.

3.02 INSTALLATION

- A. Conform to requirements of Section 02511 - Water Mains, Section 02531 - Gravity Sanitary Sewers, and Section 02532 - Sanitary Sewer Force Mains, as applicable.
- B. Install PVC pipe in accordance with Section 02317 - Excavation and Backfill for Utilities, ASTM D 2321, and manufacturer's recommendations.
- C. Water service pipe 16 inches in diameter and smaller: Installed to clear utility lines and have minimum 4 feet of cover below lowest property line grade of street, unless otherwise required by Drawings.
- D. Avoid imposing strains that will overstress or buckle the pipe when lowering pipe into trench.
- E. Hand shovel pipe bedding under the pipe haunches and along the sides of the pipe barrel and compact to eliminate voids and ensure side support.

END OF SECTION

Section 02531

GRAVITY SANITARY SEWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Gravity sanitary sewers and appurtenances, including stacks and service connections.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. Payment for gravity sanitary sewers by open-cut or within Potentially Petroleum Contaminated Area (PPCA) is on linear foot basis, complete in place, including sewer pipe, connections to existing manholes, post installation television inspection and testing. Measurement will be taken along centerline of pipe from centerline to centerline of manholes.
2. Payment for television inspection of existing gravity sanitary sewer will be on a linear foot basis. Measurement will be taken along centerline of pipe from centerline to centerline of manholes. See Section 02558 - Cleaning and Television Inspection.
3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed methods, equipment, materials and sequence of operations for sewer construction. Plan operations so as to minimize disruption of utilities to occupied facilities or adjacent property.
- C. Test Reports: Submit test reports and inspection videos as specified in Part 3 of this Section. Video tapes become property of City.

1.04 QUALITY ASSURANCE

- A. Qualifications. Install sanitary sewer that is watertight both in pipe-to-pipe joints and in pipe-to-manhole connections. Perform testing in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers.

B. Regulatory Requirements.

1. Install sewer lines to meet minimum separation distance from potable water line, as scheduled below. Separation distance is defined as distance between outside of water pipe and outside of sewer pipe. When possible, install new sanitary sewers no closer to water lines than 9 feet in all directions. Where this separation distance cannot be achieved, new sanitary sewers shall be installed as specified in this section.
2. Make notification to Project Manager when water lines are uncovered during sanitary sewer installation where minimum separation distance cannot be maintained.
3. Lay gravity sewer lines in straight alignment and grade.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Inspect pipe and fittings upon arrival of materials at job site.
- B. Handle and store pipe materials and fittings to protect them from damage due to impact, shock, shear or free fall. Do not drag pipe and fittings along ground. Do not roll pipe unrestrained from delivery trucks.
- C. Use mechanical means to move or handle pipe. Employ acceptable clamps, rope or slings around outside barrel of pipe and fittings. Do not use hooks, bars, or other devices in contact with interior surface of pipe to lift or move lined pipe.

PART 2 PRODUCTS

2.01 PIPE

- A. Provide piping materials for gravity sanitary sewers of sizes and types indicated on Drawings or as specified.
- B. Unlined reinforced concrete pipe is not acceptable.

2.02 PIPE MATERIAL SCHEDULE

- A. Unless otherwise shown on Drawings, use pipe materials that conform to requirements specified in one or more of following Sections:
 1. Section 02427 - Plastic Liner for Large-Diameter Concrete Sewers and Structures.
 2. Section 02501 - Ductile Iron Pipe and Fittings.
 3. Section 02504 - Fiberglass Reinforced Pipe.

4. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe.
5. Section 02506 - Polyvinyl Chloride Pipe.
6. Section 02508 - Extra Strength Clay Pipe.
7. Section 02611 - Reinforced Concrete Pipe.

- B. Where shown on Drawings, provide pipe meeting minimum class, dimension ratio, or other criteria indicated.
- C. Pipe materials other than those listed above shall not be used for gravity sanitary sewers.

2.03 APPURTENANCES

- A. Stacks. Conform to requirements of Section 02534 - Sanitary Sewer Service Stubs or Reconnections.
- B. Service Connections. Conform to requirements of Section 02534 - Sanitary Sewer Service Stubs or Reconnections.
- C. Roof, street or other type of surface water drains shall not be connected or reconnected into sanitary sewer lines.

2.04 BEDDING, BACKFILL, AND TOPSOIL MATERIAL

- A. Bedding and Backfill: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities, Section 02320 - Utility Backfill Materials, and Section 02321 - Cement Stabilized Sand.
- B. Topsoil: Conform to requirements of Section 02911 - Topsoil.

PART 3 EXECUTION

3.01 PREPARATION

- A. Prepare traffic control plans and set up street detours and barricades in preparation for excavation when construction will affect traffic. Conform to requirements of Section 01555 - Traffic Control and Regulation.
- B. Provide barricades, flashing warning lights, and warning signs for excavations. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights where work is in progress or where traffic is affected by work.
- C. Perform work in accordance with OSHA standards. Employ trench safety system as specified in Section 02260 - Trench Safety System for excavations over 5 feet deep.

- D. Immediately notify agency or company owning utility line which is damaged, broken or disturbed. Obtain approval from Project Manager and agency or utility company for repairs or relocations, either temporary or permanent.
- E. Remove old pavements and structures including sidewalks and driveways in accordance with requirements of Section 02221 - Removing Existing Pavements and Structures.
- F. Install and operate dewatering and surface water control measures in accordance with Section 01578 - Control of Ground Water and Surface Water.
- G. Do not allow sand, debris or runoff to enter sewer system.

3.02 DIVERSION PUMPING

- A. Install and operate required bulkheads, plugs, piping, and diversion pumping equipment to maintain sewage flow and to prevent backup or overflow. Obtain approval for diversion pumping equipment and procedures from Project Manager.
- B. Design piping, joints and accessories to withstand twice maximum system pressure or 50 psi, whichever is greater.
- C. No sewage shall be diverted into area outside of sanitary sewer.
- D. In event of accidental spill or overflow, immediately stop overflow and take action to clean up and disinfect spillage. Promptly notify Project Manager so that required reporting can be made to Texas Natural Resources Conservation Commission and Environmental Protection Agency by Project Manager.

3.03 EXCAVATION

- A. Earthwork. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities. Use bedding as indicated on Drawings.
- B. Line and Grade. Establish required uniform line and grade in trench from benchmarks identified by Project Manager. Maintain this control for minimum of 100 feet behind and ahead of pipe-laying operation. Use laser beam equipment to establish and maintain proper line and grade of work. Use of appropriately sized grade boards which are substantially supported is also acceptable. Protect boards and location stakes from damage or dislocation.
- C. Trench Excavation. Excavate pipe trenches to depths shown on Drawings and as specified in Section 02317 - Excavation and Backfill for Utilities.

3.04 PIPE INSTALLATION BY OPEN CUT

- A. Install pipe in accordance with pipe manufacturer's recommendations and as specified in following paragraphs.
- B. Install pipe only after excavation is completed, bottom of trench fine graded, bedding material is installed, and trench has been approved by Project Manager.
- C. Install pipe to line and grade indicated. Place pipe so that it has continuous bearing of barrel on bedding material and is laid in trench so interior surfaces of pipe follow grades and alignment indicated. Provide bell holes where necessary.
- D. Install pipe with spigot ends toward downstream end of flow such that water flows into bell and out the spigot.
- E. Form concentric joint with each section of adjoining pipe so as to prevent offsets.
- F. Keep interior of pipe clean as installation progresses. Remove foreign material and debris from pipe
- G. Provide lubricant, place and drive home newly laid sections with come-a-long winches so as to eliminate damage to sections. Install pipe to "home" mark where provided. Use of back hoes or similar powered equipment will not be allowed unless protective measures are provided and approved in advance by Project Manager.
- H. Keep excavations free of water during construction and until final inspection.
- I. When work is not in progress, cover exposed ends of pipes with approved plug to prevent foreign material from entering pipe.
- J. Where gravity sanitary sewer is to be installed under existing water line with separation distance of at least 2 feet and less than 9 feet, install new sewer pipe so that one full 18 foot long pipe is centered on water line crossing. Embed sewer pipe in cement stabilized sand for minimum distance of 9 feet on each side of crossing.
- K. Where gravity sanitary sewer is to be installed under existing water line with separation distance of less than 2 feet, install new sewer using pressure-rated pipe as shown on Drawings. Maintain minimum 1 foot separation distance.
- L. Where the length of the stub is not indicated, install the stub to the right-of-way line and seal the free end with an approved plug.

3.05 PIPE INSTALLATION OTHER THAN OPEN CUT

- A. For installation of pipe by augering, jacking, or tunneling, conform to requirements of specification sections on tunneling augering, jacking and microtunneling work as appropriate.

3.06 INSTALLATION OF APPURTENANCES

- A. Service Connections. Install service connections to conform to requirements of Section 2534 - Sanitary Sewer Service Stubs or Reconnections.
- B. Stacks. Construct stacks to conform to requirements of 02534 - Sanitary Sewer Service Stubs or Reconnections.
- C. Construct manholes to conform to requirements of Section 02081 - Cast-in-Place Concrete Manholes, Section 02082 - Precast Concrete Manholes, and Section 02083 - Fiberglass Manholes, as applicable. Install frames, rings, and covers to conform to requirements of Section 02084 - Frames, Grates, Rings, and Covers.

3.07 INSPECTION AND TESTING

- A. Visual Inspection: Check pipe alignment in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers.
- B. Mandrel Testing. Use Mandrel Test to test flexible pipe for deflection. Refer to Section 02533 - Acceptance Testing for Sanitary Sewers.
- C. Pipe Leakage Test. After backfilling line segment and prior to tie-in of service connections, visually inspect gravity sanitary sewers where feasible, and test for leakage in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers. Maintain piezometer installed to conform with Section 01578 - Control of Ground Water and Surface Water, until acceptance testing is completed.

3.08 BACKFILL AND SITE CLEANUP

- A. Backfill and compact soil in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Backfill trench in specified lifts only after pipe installation is approved by Project Manager.
- C. Repair and replace removed or damaged pavement, curbs, gutters, and sidewalks as specified in Section 02951 - Pavement Repair and Resurfacing.
- D. Provide hydromulch seeding in areas of commercial, industrial or undeveloped land use over surface of ground disturbed during construction and not paved or not designated to be paved. Grade surface at uniform slope to natural grade as indicated on Drawings. Provide minimum of 4 inches of topsoil as specified in Section 02911 - Topsoil and apply hydromulch according to requirements of Section 02921 - Hydromulch Seeding.
- E. Provide sodding in areas of residential land use over surface of ground disturbed during construction and not paved or not designated to be paved. Grade surface at uniform slope to natural grade as indicated on Drawings. Provide minimum of 4 inches of topsoil per Section 02911 - Topsoil. Sod disturbed areas in accordance with Section 02922 - Sodding.

3.09 POST-INSTALLATION TELEVISION INSPECTION

- A. Prior to final acceptance of newly constructed gravity sanitary sewers, perform cleaning and closed circuit television inspection. Cleaning shall include utilizing variable pressure water nozzles (3000 psi) and collection, removal, transportation and disposal of sand, debris, and liquid wastes to legal disposal sites.
- B. Select and use closed-circuit television equipment that will produce color video tape. Produce video tape using pan-and-tilt, radial viewing, pipe inspection camera that pans plus and minus 275 degrees and rotates 360 degrees. Use camera with accurate footage counter which displays on monitor exact distance of camera from starting manhole. Use camera with camera height adjustment so that camera lens is always centered at one-half inside diameter, or higher, in pipe being televised. Provide lighting system that allows features and condition of pipe to be clearly seen. Reflector in front of camera may be necessary to enhance lighting in dark or large diameter pipe.
- C. Perform television inspection of gravity sanitary sewers as follows:
 - 1. Videos shall pan beginning and ending manholes to demonstrate that debris has been removed. Camera operator shall slowly pan each service connection and where sewer transitions from one pipe material to another.
 - 2. Video tapes shall be continuous for pipe segments between manholes. Do not leave gaps in video taping of segment between manholes and do not show single segment on more than one video tape.
 - 3. No flow is allowed in gravity sanitary sewer while performing post-installation television inspection.
- D. Provide video tapes in VHS format, recorded at Standard Play (SP). Two labels are required. Place one label on spine and other on face of each video tape. Permanently label each video tape with following information.

Spine of Tape

Wastewater File No.: _____ Contractor's Name:
Inspection Type: <input type="checkbox"/> Survey <input type="checkbox"/> Pre-Installation <input type="checkbox"/> Post-Installation
Tape No.: _____ Date Televised: _____ Date Submitted:
Basin No:

Face of Tape

Manhole No. From	Manhole No. To	Pipe Diameter	Pipe Length	Street
_____	_____	_____	_____	
_____	_____	_____	_____	
_____	_____	_____	_____	
_____	_____	_____	_____	

- E. For each video tape provide completed TV Inspection Report, as attached at end of this section. TV Inspection Report is written/narrated log of pipe conditions and service connections, indexed to footage counter.
- F. Upon completion of video tape reviews by Project Manager, Contractor will be notified regarding final acceptance of sewer segment.

END OF SECTION

GRAVITY SANITARY SEWERS

TELEVISION INSPECTION CODES

HEADER INFORMATION

LOCATION	
A	STREET ROW, HEAVY TRAFFIC
B	STREET ROW, LIGHT TRAFFIC
C	EASEMENT, POOR ACCESS
D	EASEMENT, GOOD ACCESS
E	PARKING LOT, POOR ACCESS
F	PARKING LOT, GOOD ACCESS
G	ALLEY, POOR ACCESS
H	ALLEY, GOOD ACCESS
I	OPEN AREA, POOR ACCESS
J	OPEN AREA, GOOD ACCESS

SURFACE COVER

A	ASPHALT STREET
B	CONCRETE STREET
C	SHELL STREET
D	SIDEWALK
E	TREES/SHRUBS
F	CLOSE TO FENCE
G	OPEN AREA
H	MOVABLE BUILDING
I	UNMOVABLE BUILDING
J	OVERHEAD UTILITIES
K	WATERWAY OR RAILWAY
L	HIGHWAY OR RUNWAY
M	PIPE ABOVE GROUND

PIPE TYPE

ABS	ACRYLONITRILE BUTADIENE STYRENE
BRK	BRICK
CIP	CAST IRON PIPE
CMP	CORRUGATED METAL PIPE
CON	POURED IN PLACE CONCRETE
CPP	CURED IN PLACE PIPE
DIP	DUCTILE IRON PIPE
FRP	FIBERGLASS REINFORCED PIPE
PLP	PLASTIC LINED CONCRETE PIPE
PEP	POLYETHYLENE PIPE
PVC	POLYVINYLCHLORIDE PIPE
RCP	REINFORCED CONCRETE PIPE
RPM	REINFORCED PLASTIC MORTAR PIPE
URC	UNREINFORCED CONCRETE PIPE
VCP	VITRIFIED CLAY PIPE

WEATHER

DRY - WET

CODE DESCRIPTIONS

CRACKS

RC-RADIAL CODES	DESCRIPTION	LC-LONGITUDINAL USE IN
A (1)	< 1/2" W, < 1' L	CRK
B (2)	< 1/2" W, 1' - 2' L	CRK
C (3)	< 1/2" W, > 2' L	CRK
D (4)	> 1/2" W, < 1' L	CRK
E (5)	> 1/2" W, 1' - 2' L	CRK
F (6)	> 1/2" W, > 2' L	CRK
G (7)	HOLE IN PIPE - SMALL	
H (8)	PIPE MISSING - < 60°	
I (9)	PIPE MISSING - > 60°	

JOINTS

CODES	DESCRIPTION	USE IN
MJ - MISALIGNED JOINT		BJ - BROKEN JOINT
A (3)	DRP JT > 90% CLEAR	MJ
B (6)	DRP JT 80 - 90% CLEAR	MJ
C (9)	DRP JT < 80% CLEAR	MJ
D (3)	SHF JT > 90% CLEAR	MJ
E (6)	SHF JT 80 - 90% CLEAR	MJ
F (9)	SHF JT < 80% CLEAR	MJ
G (1)	WD JT 2" - 3"	MJ
H (2)	WD JT 3" - 4"	MJ
I (3)	WD JT > 4"	MJ
J (2)	BRK JT - LIGHT	BJ
K (4)	BRK JT - MEDIUM BJ	
L (6)	BRK JT - HEAVY	BJ
N (0)	VISIBLE GASKET	MJ
O (0)	LEAKING AT JOINT	MJ

LATERALS (L)

CODES	DESCRIPTION
A (1)	PRT SER 0" - 1"
B (2)	PRT SER 1" - 2"
C (3)	PRT SER 2" - 3"
D (4)	PRT SER 3" +
E (5)	DEFECTIVE - SERVICE CONN.
F (6)	DEAD/UNUSED SERVICE
G (7)	FACTORY SERVICE
H (0)	PLUMBER SERVICE

ROOTS (R)

CODES	DESCRIPTION
A (1)	ROOTS - LIGHT
B (2)	ROOTS - MEDIUM
C (3)	ROOTS - HEAVY

DEBRIS (D)

CODES	DESCRIPTION
A	DEBRIS - LIGHT
B	DEBRIS - MEDIUM
C	DEBRIS - HEAVY
D	GREASE - LIGHT
E	GREASE - MEDIUM
F	GREASE - HEAVY

INFLOW/INFILTRATION (I)

CODES	DESCRIPTION
A (3)	I/I - LIGHT (0-1 GPM)
B (6)	I/I - MEDIUM (1-5 GPM)
C (9)	I/I - HEAVY (> 5 GPM)
D (2)	I/I - SOME EVIDENCE
E (4)	I/I - CONSIDERABLE EVIDENCE
F (6)	I/I - GREAT EVIDENCE
G (0)	I/I - NO EVIDENCE

ALIGNMENT (A)

CODES	DESCRIPTION
A	BEGIN 1/4 PIPE WATER
B	BEGIN 1/2 PIPE WATER
C	CAMERA UNDERWATER
D	END CAMERA UNDERWATER
E	END 1/2 PIPE WATER
F	END 1/4 PIPE WATER

STRUCTURAL

CODES	DESCRIPTION	USE IN
DS - DETERIORATED; OS - OVALITY; CS - COLLAPSED		
A (3)	LINE DET - LIGHT DS	
B (6)	LINE DET - MEDIUM	DS
C (9)	LINE DET - HEAVY	DS
D (3)	OVAL < 5%	OS
E (6)	OVAL > 5% & < 10%	OS
F (9)	OVAL > 10%	OS
G (9)	COLLAPSED	CS
H (0)	PIPE DET - HEAVY DS	
L (0)	PIPE DET - LIGHT	DS
M (0)	PIPE DET - MEDIUM	DS
N (0)	PIPE DET - NONE	DS
O	LINE DET - NONE DS	
Z (0)	AT MANHOLE NUMBER	CS

Section 02532

SANITARY SEWER FORCE MAINS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sanitary sewer force mains.

1.02 MEASUREMENT AND PAYMENT

- A. Unit Prices.

1. Payment for installation of force main pipe by open-cut, augered with or without casing, or within limits of Potentially Petroleum Contaminated Area (PPCA) is on linear foot basis. Measurement will be taken along center line of pipe from end to end. Payment will be made for each foot of force main installed, complete in place including pipe, excavation, bedding, backfill and special backfill, shoring, earthwork, connections to existing manholes, acceptance testing, and pipe and accessories.
2. Payment for installation of force main pipe at a bayou crossing is on a lump sum basis.
3. The Unit Price item identifies line segments between stations as shown on Drawings.
4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

- B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCE STANDARDS

- A. ACI 318 - ACI Building Code and Commentary.
- B. ASTM D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 C and 30 C with a Vitreous Silica Dilatometer.
- C. ASTM D 2310 - Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced- Thermosetting-Resin) Pipe.
- D. ASTM D 2992 - Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe and Fittings.

- E. ASTM D 2996 - Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- F. Uni-Bell UNI-B-3 Polyvinyl Chloride (PVC) Pressure Pipe (complying with AWWA C 900).

1.04 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Submit proposed methods, equipment, materials, and sequence of operations for force main construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.
- C. Force mains 24 inches in diameter and larger: Submit shop drawings and design calculations for joint restraint systems using reinforced concrete encasement of pressure pipe and fittings.
- D. Submit qualifications, proposed methods, equipment, materials, and sequence for acceptance testing of pipeline. Submit evidence of experience with pipeline proving by pigging for at least three projects of equal or greater scope; project list shall include dates, size and length of pipe, location, owner name, contact person, and telephone number. Provide certificate of training by manufacturer of pigging equipment being used.
- E. Submit test reports as specified in Part 3 of this Section.

PART 2 PRODUCTS

2.01 PIPE FITTING MATERIAL SCHEDULE

- A. Unless otherwise shown on Drawings, use pipe materials that conform to requirements specified in one or more of the following Sections:
 - 1. Section 02501 - Ductile-Iron Pipe and Fittings.
 - 2. Section 02504 - Fiberglass Reinforced Pipe.
 - 3. Section 02505 - High Density Polyethylene Solid and Profile Wall Pipe (HDPE).
 - 4. Section 02506 - Polyvinyl Chloride Pipe. Provide Lined Ductile-Iron Fittings in Accordance with Section 02501 - Ductile-Iron Pipe and Fittings.
 - 5. Filament-wound Fiberglass Pipe
 - a. Provide dual-angle, filament-wound fiberglass reinforced epoxy pipe with integral epoxy liner and exterior coating in sizes from 4-inch to 16-inch

diameter. Conform to requirements of ASTM D 2310 or ASTM D 2996, depending on size and class of pipe required.

- b. Fiberglass pipe shall have resin rich liner of following thickness:
 - (1) For nominal sizes 4 inches through 6 inches, conform to ASTM D 2310 RTRP 11CX and ASTM D 2996 RTRP 11CX 5430, with minimum liner thickness of 0.020 inch.
 - (2) For nominal sizes 8 inches through 16 inches, conform to ASTM D 2310 RTRP 11FX and ASTM D 2996 RTRP 11FX 3210, with minimum liner thickness of 0.025 inch.
 - (3) The coefficient of linear thermal expansion shall be 8.5×10^{-6} inch/inch/degrees F for 4-inch through 6-inch pipe and 12.0×10^{-6} inch/inch/degrees F for 8-inch through 16-inch pipe in accordance with ASTM D 696.
- c. Hydrostatic design value shall be not less than 21,000 psi when tested in accordance with ASTM D 2992(B) and not less than 8000 psi when tested according to ASTM D 2992(A).
- d. Burial depths for pipes with standard wall thickness shall be between 3 feet and 25 feet.
- e. Joints: Heavy duty threaded coupling system with positive o-ring seals. For 4-inch through 6-inch diameters, provide mechanical joints with fast advance, acme-type threads. Male threaded portion of couplings shall lock mechanical joints for couplings for pipe diameters of 8 inches through 16 inches. Axial movement of couplings shall allow up to 2 degrees of angular deflection without affecting o-ring seal integrity.
- f. Fittings may be contact molded, compression molded, filament wound, or mitered. Fitting must also be capable of withstanding test pressures.
- g. Pipes, fittings, and other components in this system shall be rated for service to 150 psig at 120 degrees F. Components shall be rated at or above design pressure of system.

2.02 THRUST RESTRAINT

- A. Unless otherwise shown on Drawings, provide concrete thrust blocking for force mains up to 12-inches in diameter, to prevent movement of buried lines under pressure at bends, tees, caps, valves and hydrants. Blocking shall be Portland cement concrete, as specified in Section 03315 - Concrete for Utility Construction. Place concrete in accordance with details on Drawings. Place thrust blocks between undisturbed ground and fittings. Anchor fittings to

thrust blocks so that pipe and fitting joints are accessible for repairs. Concrete shall extend from 6 inches below pipe or fitting to 12 inches above.

- B. For force mains larger than 12 inches in diameter, and where indicated on Drawings, provide restrained joints conforming to requirements of force main pipe material specifications. Install restrained joints for length of pipe on both sides of each bend or fitting for full length shown on Drawings.
- C. Horizontal and vertical bends between zero and 10 degrees deflection angle will not require thrust blocks or harnessed or restrained joints.
- D. Horizontal and vertical bends between 10 degrees and 90 degrees deflection angle shall have thrust restraint as shown on Drawings.
- E. Provide thrust restraint at tees, plugs, blowoff drains, valves, and caps, as indicated.
- F. Reinforced concrete encasement of force main pipe and fittings may be used in lieu of manufactured joint restraint systems. Alternate joint restraint systems using reinforced concrete encasement shall conform to following design requirements.
 - 1. Design calculations shall be performed and sealed by Professional Engineer licensed in State of Texas.
 - 2. Base design calculations upon soil parameters quantified in geotechnical report for site where alternative thrust restraint system is to be installed. When data is not available for site, use parameters recommended by geotechnical engineer.
 - 3. The design system pressure shall be specified test pressure.
 - 4. The following safety factors shall be used in sizing restraint system:
 - a. Apply factor of safety equal to 1.5 for passive soil resistance.
 - b. Apply factor of safety equal to 2.0 for soil friction.
 - 5. Contain encasement entirely within standard trench width and terminate on both ends at pipe bell or coupling.

6. Concrete encasement reinforcement steel shall be designed for all loads, including internal pressure and longitudinal forces. Concrete design shall be in accordance with ACI 318.

PART 3 EXECUTION

3.01 PIPE INSTALLATION BY OPEN-CUT

- A. Perform excavation, bedding, and backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.
- B. Wrap ductile-iron pipe and fittings with polyethylene wrap in accordance with requirements of Section 02528 - Polyethylene Wrap. Do not install polyethylene wrap on ductile iron pipe protected by cathodic protection system or fusion bonded or polyurethane coated fittings.
- C. Install pipe in accordance with pipe manufacturer's recommendations and as specified in following paragraphs.
- D. Install pipe only after excavation is completed, bottom of trench is fine graded, bedding material is installed, and trench has been approved by Project Manager.
- E. Install pipe to line and grade indicated. Place pipe so that it has continuous bearing of barrel on bedding material and is laid in trench so interior surfaces of pipe follow grades and alignment indicated. Provide bell holes where necessary.
- F. Install pipe with spigot ends toward direction of flow. Form concentric joint with each section of adjoining pipe so as to prevent offsets.
- G. Keep interior of pipe clean as installation progresses. Where cleaning after laying pipe is difficult because of small pipe size, use suitable swab or drag in pipe and pull it forward past each joint immediately after joint has been completed. Remove foreign material and debris from pipe.
- H. Provide lubricant, place and drive home newly-laid sections with come-a-long winches so as to eliminate damage to sections. Install pipe to "home" mark where provided. Use of back hoes or similar powered equipment will not be allowed unless protective measures are provided and approved in advance by Project Manager.
- I. Keep excavations free of water during construction and until final inspection.
- J. When work is not in progress, cover exposed ends of pipes with approved plug to prevent foreign material from entering pipe.

- K. Where sanitary sewer force main is to be installed under existing water line with separation distance of less than 2 feet, install one full joint length of pipe, minimum 18 foot length, centered on water line and maintain minimum 6-inch separation distance.

3.02 PIPE INSTALLATION OTHER THAN OPEN-CUT

- A. For installation of pipe by augering, jacking, or tunneling, conform to requirements of specification section of augering or tunneling work.

3.03 HYDROSTATIC TESTING

- A. After pipe and appurtenance have been installed, test line and drain. Prevent damage to Work or adjacent areas. Use clean water to perform tests.
- B. Project Manager may direct tests of relatively short sections of completed lines to minimize traffic problems or potential public hazards.
- C. Test pipe in presence of Project Manager.
- D. Test pipe at 150 psig or 1.5 times design pressure of pipe, whichever is greater. Design pressure of force main shall be rated total dynamic head of lift station pump.
- E. Test pipe at required pressure for minimum of 2 hours according to requirements of UNI-B-3.
- F. Maximum allowable leakage shall be as calculated by following formula:

$$L = (S) (D) (P^{0.5}) / 133,200$$

Where:

L	=	Leakage in gallons per hour.
S	=	Length of pipe in feet.
D	=	Inside diameter of pipe in inches.
P	=	Pressure in pounds per square inch.

- G. Correct defects, cracks, or leakage by replacement of defective items or by repairs as approved by Project Manager.
- H. Plug openings in force main after testing and flushing. Use cast iron plugs or blind flanges to prevent debris from entering tested pipeline.

3.04 PIGGING TEST

- A. After completion of hydrostatic testing and prior to final acceptance, test force mains longer than 200 feet by pigging to ensure piping is free of obstructions.

- B. Pigs: Provide proving pigs manufactured of open-cell polyurethane foam body, without coating or abrasives which would scratch or otherwise damage interior pipe wall surface or lining. Pigs shall be able to pass through reductions of up to 65 percent of nominal cross-sectional area of pipe. Pigs shall be able to pass through standard fittings such as 45-degree and 90-degree elbows, crosses, tees, wyes, gate valves, or plug valves, as applicable to force main being tested.

- C. Test Execution: Conduct pigging test in presence of Project Manager. Provide at least 48-hours notice of scheduled pigging of force main prior to commencing test.

END OF SECTION

Section 02533

ACCEPTANCE TESTING FOR SANITARY SEWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Acceptance testing of sanitary sewers including:

1. Visual inspection of sewer pipes
2. Mandrel testing for flexible sewer pipes.
3. Leakage testing of sewer pipes.
4. Leakage testing of manholes.
5. Smoke testing of point repairs.
6. Television and Video Inspection.

B. All tests listed in this Section are not necessarily required on this Project. Required tests are named in other Sections which refer to this Section for testing criteria and procedures.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for acceptance testing under this Section. Include payment in unit price for work requiring acceptance testing.
2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM C 828 - Standard Test Method for Low Pressure Air Test of Vitrified Clay Pipe Lines.

- B. ASTM C 924 - Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
- C. ASTM D 3034 - Standard Specification for Type PSM Polyethylene (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- D. ASTM F 794 - Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
- E. ASTM F 1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air.
- F. ASTM C 1244 Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

1.04 PERFORMANCE REQUIREMENTS

- A. Gravity flow sanitary sewers are required to have straight alignment and uniform grade between manholes.
- B. Flexible pipe, including "semi-rigid" pipe, is required to show no more than 5 percent deflection. Test pipe no sooner than 30 days after backfilling of line segment but prior to final acceptance using standard mandrel to verify that installed pipe is within specified deflection tolerances.
- C. Must meet Texas Commission on Environmental Quality (TCEQ) Testing Requirements Chapter-217-57.

1.05 SUBMITTALS

- A. Conform to requirements of Section 01330 - Submittal Procedures.
- B. Test Plan: Before testing begins and in adequate time to obtain approval through submittal process, prepare and submit test plan for approval by Project Manager. Include testing procedures, methods, equipment, and tentative schedule. Obtain advance written approval for deviations from Drawings and Specifications.
- C. Test Reports: Submit test reports for each test on each segment of sanitary sewer.

1.06 GRAVITY SANITARY SEWER QUALITY ASSURANCE

- A. Repair, correct, and retest manholes or sections of pipe which fail to meet specified requirements when tested.

- B. Provide testing reports and video tape of television inspection as directed by Project Manager.
- C. Upon completion of tape reviews by Project Manager, Contractor will be notified regarding final acceptance of sewer segment.

1.07 SEQUENCING AND SCHEDULING

- A. Perform testing as work progresses. Schedule testing so that no more than 1000 linear feet of installed sewer remains untested at one time.
- B. Coordinate testing schedules with Project Manager. Perform testing under observation of Project Manager.

PART 2 PRODUCTS

2.01 DEFLECTION MANDREL

- A. Mandrel Sizing. Rigid mandrel shall have outside diameter (O.D.) equal to 95 percent of inside diameter (I.D.) of pipe. Inside diameter of pipe, for purpose of determining outside diameter of mandrel, shall be average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and average inside diameter for I.D. controlled pipe, dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
- B. Mandrel Design. Rigid mandrel shall be constructed of metal or rigid plastic material that can withstand 200 psi without being deformed. Mandrel shall have nine or more "runners" or "legs" as long as total number of legs is odd number. Barrel section of mandrel shall have length of at least 75 percent of inside diameter of pipe. Rigid mandrel shall not have adjustable or collapsible legs which would allow reduction in mandrel diameter during testing. Provide and use proving ring for modifying each size mandrel.
- C. Proving Ring. Furnish "proving ring" with each mandrel. Fabricate ring of 1/2-inch-thick, 3-inch-wide bar steel to diameter 0.02 inches larger than approved mandrel diameter.
- D. Mandrel Dimensions (5 percent allowance). Average inside diameter and minimum mandrel diameter are specified in Table 02533-5, Pipe vs. Mandrel Diameter, at end of this Section. Mandrels for higher strength, thicker wall pipe or other pipe not listed in table may be used when approved by Project Manager.

2.02 EXFILTRATION TEST

- A. Water Meter: Obtain transient water meter from City for use when water for testing will be taken from City system. Conform to City requirements for water meter use.
- B. Test Equipment:
 - 1. Pipe plugs.
 - 2. Pipe risers where manhole cone is less than 2 feet above highest point in pipe or service lead.

2.03 INFILTRATION TEST

- A. Test Equipment:
 - 1. Calibrated 90 degree V-notch weir.
 - 2. Pipe plugs.

2.04 LOW PRESSURE AIR TEST

- A. Minimum Requirement for Equipment:
 - 1. Control panel
 - 2. Low-pressure air supply connected to control panel.
 - 3. Pneumatic plugs: Acceptable size for diameter of pipe to be tested; capable of withstanding internal test pressure without leaking or requiring external bracing.
 - 4. Air hoses from control panel to:
 - a. Air supply.
 - b. Pneumatic plugs.
 - c. Sealed line for pressuring.
 - d. Sealed line for monitoring internal pressure.
- B. Testing Pneumatic Plugs: Place pneumatic plug in each end of length of pipe on ground. Pressurize plugs to 25 psig; then pressurize sealed pipe to 5 psig. Plugs are acceptable when they remain in place against test pressure without external aids.

2.05 GROUND WATER DETERMINATION

- A. Equipment: Pipe probe or small diameter casing for ground water elevation determination.

2.06 SMOKE TESTING

- A. Equipment:
 - 1. Pneumatic plugs.
 - 2. Smoke generator as supplied by Superior Signal Company, or approved equal.
 - 3. Blowers producing 2500 scfm minimum.

PART 3 EXECUTION

3.01 PREPARATION

- A. Provide labor, equipment, tools, test plugs, risers, air compressor, air hose, pressure meters, pipe probe, calibrated weirs, or any other device necessary for proper testing and inspection.
- B. Determine selection of test methods and pressures for gravity sanitary sewers based on ground water elevation. Determine ground water elevation using equipment and procedures conforming to Section 01578 - Control of Ground Water and Surface Water.

3.02 VISUAL INSPECTION OF GRAVITY SANITARY SEWERS

- A. Check pipe alignment visually by flashing light between structures. Verify if alignment is true and no pipes are misplaced. In case of misalignment or damaged pipe, remove and re-lay or replace pipe segment.

3.03 MANDREL TESTING FOR GRAVITY SANITARY SEWERS

- A. Perform deflection testing on flexible and semi-rigid pipe to confirm pipe has no more than 5 percent deflection. Mandrel testing shall conform to ASTM D 3034. Perform testing no sooner than 30 days after backfilling of line segment, but prior to final acceptance testing of line segment.
- B. Pull approved mandrel by hand through sewer sections. Replace any section of sewer not passing mandrel. Mandrel testing is not required for stubs.
- C. Retest repaired or replaced sewer sections.

3.04 LEAKAGE TESTING FOR GRAVITY COLLECTION SYSTEM PIPES

- A. For a collection system pipe that will transport wastewater by gravity flow, test gravity sanitary sewer pipes for leakage by either exfiltration or infiltration methods, as appropriate, or with low pressure air testing.
- B. Compensating for Ground Water Pressure:
 - 1. Where ground water exists, install pipe nipple at same time sewer line is placed. Use 1/2-inch capped pipe nipple approximately 10 inches long. Make installation through manhole wall on top of sewer line where line enters manhole.
 - 2. Immediately before performing line acceptance test, remove cap, clear pipe nipple with air pressure, and connect clear plastic tube to nipple. Support tube vertically and allow water to rise in tube. After water stops rising, measure height in feet of water over invert of pipe. Divide this height by 2.3 feet/psi to determine ground water pressure to be used in line testing.
- C. Exfiltration test:
 - 1. Determine ground water elevation.
 - 2. Plug sewer in downstream manhole.
 - 3. Plug incoming pipes in upstream manhole.
 - 4. Install riser pipe in outgoing pipe of upstream manhole when highest point in service lead (house service) is less than 2 feet below bottom of manhole cone.
 - 5. Fill sewer pipe and manhole or pipe riser, when used, with water to point 2-1/2 feet above highest point in sewer pipe, house lead, or ground water table, whichever is highest.
 - 6. Allow water to stabilize for one to two hours. Take water level reading to determine drop of water surface, in inches, over one-hour period, and calculate water loss (1 inch of water in 4 feet diameter manhole equals 8.22 gallons) or measure quantity of water required to keep water at same level. Loss shall not exceed that calculated from allowable leakage according to Table 02533-1 at end of this Section.
- D. Infiltration test: Ground water elevation must be not less than 2.0 feet above highest point of sewer pipe or service lead (house service).
 - 1. Determine ground water elevation.

2. Plug incoming pipes in upstream manhole.
 3. Insert calibrated 90 degree V-notch weir in pipe on downstream manhole.
 4. Allow water to rise and flow over weir until it stabilizes.
- E. Low Air Pressure Test: When using this test conform to ASTM C 828, ASTM C 924, or ASTM F 1417, as applicable, with holding time not less than that listed in Table 02533-2.
1. Low Pressure Air testing for sections of pipe shall be limited to lines less than 36-inch average inside diameter. Refer to charts 02533-2 and 02533-3.
 2. Lines 36-inch average inside diameter and larger shall be tested at each joint. Minimum time allowable for pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch during joint test shall be 10 seconds, regardless of pipe size.
- F. Retest: Repair and retest any section of pipe which fails to meet requirements.

3.05 TEST CRITERIA TABLES

- A. Exfiltration and Infiltration Water Tests: Refer to Table 02533-1, Water Test Allowable Leakage, at end of this Section.
- B. Low Pressure Air Test:
1. Times in Table 02533-2, Time Allowed for Pressure Loss from 3.5 psig to 2.5 psig, at end of this Section, are based on equation from Texas Commission on Environmental Quality (TCEQ) Design Criteria 217.57

		$T = 0.0850(D)(K)/(Q)$
where:	T	= time for pressure to drop 1.0 pounds per square inch gauge in seconds
	K	= 0.000419 DL, but not less than 1.0
	D	= average inside diameter in inches
	L	= length of line of same pipe size in feet
	Q	= rate of loss, 0.0015 ft ³ /min./sq. ft. internal surface

2. Since K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as given in Table 02533-3, Minimum Testing Times for Low Pressure Air Test.

- Notes:
1. when two sizes of pipe are involved, compute time by ratio of lengths involved.
 2. Lines with 27-inch average inside diameter and larger may be air tested at each joint.
 3. Lines with average inside diameter greater than 36 inches must be air tested for leakage at each joint.
 4. If joint test is used, perform visual inspection of joint immediately after testing.
 5. For joint test, pipe is to be pressurized to 3.5 psi greater than pressure exerted by groundwater above pipe. Once pressure has stabilized, minimum times allowable for pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be 10 seconds.

3.06 LEAKAGE TESTING FOR MANHOLES

- A. After completion of manhole construction, wall sealing, or rehabilitation, but prior to backfilling, test manholes for water tightness using hydrostatic or vacuum testing procedures.
- B. Plug influent and effluent lines, including service lines, with suitably-sized pneumatic or mechanical plugs. Ensure plugs are properly rated for pressures required for test; follow manufacturer's safety and installation recommendations. Place plugs minimum of 6 inches outside of manhole walls. Brace inverts to prevent lines from being dislodged when lines entering manhole have not been backfilled.
- C. Vacuum testing:
 1. Install vacuum tester head assembly at top access point of manhole and adjust for proper seal on straight top section of manhole structure. Following manufacturer's instructions and safety precautions, inflate sealing element to recommended maximum inflation pressure; do not over-inflate.
 2. Evacuate manhole with vacuum pump to 10 inches mercury (Hg), disconnect pump, and monitor vacuum for time period specified in Table 02533-4, Vacuum Test Time Table.
 3. A manhole passes the test if after 2.0 minutes and with all valves closed, the vacuum is at least 9.0 inches of mercury (Hg).

D. Perform hydrostatic exfiltration testing as follows:

1. Seal wastewater lines coming into manhole with internal pipe plug. Then fill manhole with water and maintain it full for at least one hour.
2. The maximum leakage for hydrostatic testing shall be 0.025 gallons per foot diameter per foot of manhole depth per hour.
3. If water loss exceeds amount tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

3.07 SMOKE TEST PROCEDURES FOR POINT REPAIRS

A. Application: Perform smoke test to:

1. Locate points of line failure for point repair.
2. Determine when point repairs are properly made.
3. Determine when service connections have been reconnected to rehabilitated sewer.
4. Check integrity of connections to newly replaced service taps to liners and to existing private service connections.

B. Limitations: Do not backfill service taps until completion of this test. Test only those taps in single manhole section at one time. Keep number of open excavations to minimum.

C. Preparation: Prior to smoke testing, give written notices to area residents no fewer than 2 days, nor more than 7 days, prior to proposed testing. Also give notice to City of Houston Police and Fire Departments 24 hours prior to actual smoke testing.

D. Isolate Section: Isolate manhole section to be tested from adjacent manhole sections to keep smoke localized. Temporarily seal annular space at manhole for sliplined sections.

E. Smoke Introduction:

1. Operate equipment according to manufacturer's recommendation and as approved by Project Manager.
2. Conduct test by forcing smoke from smoke generators through sanitary sewer main and service connections. Operate smoke generators for minimum of 5 minutes.

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3. Introduce smoke into upstream and downstream manhole as appropriate. Monitor tap/connection for smoke leaks. Note sources of leaks.
- F. Repair and Retest: Repair and replace taps or connections noted as leaking and then retest. Taps and connections may be left exposed in only one manhole section at time. When repair or replacement, testing or retesting, and backfilling of excavation is not completed within one work day, properly barricade and cover each excavation as approved by Project Manager.
- G. Service Connections: On houses where smoke does not issue from plumbing vent stacks to confirm reconnection of sewer service to newly installed liner pipe, perform dye test to confirm reconnection. Introduce dye into service line through plumbing fixture inside structure or sewer cleanout immediately outside structure and flush with water. Observe flow at service reconnection or downstream manhole. Detection of dye confirms reconnection.

3.08 TELEVISION AND VIDEO INSPECTION PROCEDURE

- A. Refer to Document 02588- Cleaning and Television Inspection

Table 02533-1
WATER TEST ALLOWABLE LEAKAGE

DIAMETER OF RISER OR STACK IN INCHES	VOLUME PER INCH OF DEPTH		ALLOWANCE LEAKAGE*	
	INCH	GALLONS	PIPE SIZE IN INCHES	GALLONS/MINUTE PER 100 FT.
1	0.7854	.0034	6	0.0039
2	3.1416	.0136	8	0.0053
2.5	4.9087	.0212	13	0.0066
3	7.0686	.0306	12	0.0079
4	12.5664	.0306	15	0.0099
5	19.6350	.0544	18	0.0118
6	28.2743	.1224	21	0.0138
8	50.2655	.2176	24	0.0158
			27	0.0177
			30	0.0197
			36	0.0237
			42	0.0276
For other diameters, multiply square of diameters by value for 1" diameter.			Equivalent to 50 gallons per inch of inside diameter per mile per 24 hours.	

**ACCEPTANCE TESTING
FOR SANITARY SEWERS**

* Allowable leakage rate must not exceed 10 gallons per inch of inside diameter per mile per 24 hours, when sewer is identified as located within 25-year flood plain.

Table 02533-2
ACCEPTANCE TESTING FOR
SANITARY SEWERS

TIME ALLOWED FOR PRESSURE LOSS FROM 3.5 PSIG TO 2.5 PSIG														
Pipe Diam. (in)	Min. Time (min:sec)	Length for Min. Time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)										
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	500 ft	550 ft	600 ft
6	5:40	398	0.8548	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07	7:50	8:33
8	7:33	298	1.5196	7:33	7:33	7:33	7:33	7:36	8:52	10:08	11:24	12:40	13:56	15:12
10	9:27	239	2.3743	9:27	9:27	9:27	9:54	11:52	13:51	15:50	17:48	19:47	21:46	23:45
12	11:20	199	3.4190	11:20	11:20	11:20	14:15	17:06	19:57	22:48	25:39	28:30	31:20	34:11
15	14:10	159	5.3423	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31	48:58	53:25
18	17:00	133	7.6928	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06	70:31	76:56
21	19:50	114	10.4708	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15	95:59	104:42
24	22:40	99	13.6762	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58	125:22	136:46
27	25:30	88	17.3089	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	144:14	158:40	173:05
30	28:20	80	21.3690	35:37	53:25	71:14	89:02	106:51	124:39	142:28	160:16	178:05	195:53	213:41
33	31:10	72	25.8565	43:06	64:38	86:11	107:44	129:17	150:50	172:23	193:55	215:28	237:01	258:34

**ACCEPTANCE TESTING
FOR SANITARY SEWERS**

Table 02533-3
MINIMUM TESTING TIMES FOR LOW
PRESSURE AIR TEST

PIPE DIAMETER (INCHES)	MINIMUM TIME (SECONDS)	LENGTH FOR MINIMUM TIME (FEET)	TIME FOR LONGER LENGTH (SECONDS/FT)
6	340	398	0.855
8	454	298	1.520
10	567	239	2.374
12	680	199	3.419
15	850	159	5.342
18	1020	133	7.693
21	1190	114	10.471
24	1360	100	13.676
27	1530	88	17.309
30	1700	80	21.369
33	1870	72	25.856

Table 02533-4
VACUUM TEST TIME TABLE

DEPTH IN FEET	TIME IN SECONDS BY PIPE DIAMETER		
	48"	60"	72"
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
*	5.0	6.5	8.0

*Add T times for each additional 2-foot depth.
(The values listed above have been extrapolated from ASTM C 1244)

**ACCEPTANCE TESTING
FOR SANITARY SEWERS**

Table 02533-5
PIPE VS. MANDREL DIAMETER

<u>Material and Wall Construction</u>	<u>Nominal Size (Inches)</u>	<u>Average I.D. (Inches)</u>	<u>Minimum Mandrel Diameter (Inches)</u>
PVC-Solid (SDR 26) 5.476	6	6	5.764
	8	7.715	7.329
	10	9.646	9.162
PVC-Solid (SDR 35) 11.150	12	12	11.737
	15	14.374	13.655
	18	17.629	16.748
	21	20.783	19.744
	24	23.381	22.120
	27	26.351	25.033
	PVC-Truss 7.363	8	8
10		9.750	9.263
12		11.790	11.201
15		14.770	14.032
PVC-Profile (ASTM F 794)	12	11.740	11.153
	15	14.370	13.652
	18	17.650	16.768
	21	20.750	19.713
	24	23.500	22.325
	27	26.500	25.175
	30	29.500	28.025
	36	35.500	33.725
	42	41.500	39.425
	48	47.500	45.125
HDPE-Profile	18	18.000	17.100
	21	21.000	19.950
	24	24.000	22.800
	27	27.000	25.650
	30	30.000	28.500
	36	36.000	34.200
	42	42.000	39.900
	48	48.000	45.600
	54	54.000	51.300
	60	60.000	57.000
Fiberglass 11.822 (Class SN 46)	12	12	12.85
	18	18.66	17.727

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20	20.68	19.646
24	24.72	23.484
30	30.68	29.146
36	36.74	34.903
42	42.70	40.565
48	48.76	46.322
54	54.82	52.079
60	60.38	57.361

END OF SECTION

SPECIFICATION TABLE OF CONTENTS:

16010	Basic Electrical Requirements
16111	Conduit, Fittings, and Bodies
16120	600-Volt Power and Control Cable
16126	Instrumentation Cable
16131	Device, Pull, Junction, and Terminal Boxes and Wireways
16140	Wiring Devices
16160	Cabinets and Enclosures
16165	Disconnect Switches
16170	Grounding and Bonding
16195	Electrical Identification
16402	Underground Duct Banks
16461	Dry Type Transformers



9/1/2022

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Basic requirements specifically applicable to the work of Division 16 - Electrical Requirements.
- B. The Contractor shall furnish equipment, materials, and labor for assembly and installation plus check-out and start-up of the complete electrical system as shown on the Drawings and stipulated in the Specifications.

1.02 REFERENCES

- A. As a minimum requirement, the electrical system shall be constructed in accordance with:
 - 1. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), No. 70 - National Electrical Code (NEC).
 - 2. Accepted Codes of the City of Wills Point, Texas.
 - 3. Other applicable Codes and Standards as referenced in other Specifications.
- B. Comply with local, county, state and federal regulations and codes in effect as of date of purchase.
- C. Equipment of foreign manufacture must meet U.S. codes and standards.
- D. Equipment and materials shall conform to requirements of specification and to the criteria provided in data sheets for the project.

1.03 QUALITY ASSURANCE

- A. Product Conformance Certificate and Quality Assurance Release. Submit an overall conformance certificate for electrical components signed by the person responsible for product quality. Specifically identify the purchased material or equipment by project name and location, purchase order number, supplements, and item number where applicable, including materials and services provided by others. Indicate that all requirements have been met and identify any approved deviations.

B. Field Inspection

1. Electrical work shall be inspected and approved by the local code inspector and the Project Manager prior to starting the 7-day test or scheduling training.
2. Contractor shall give a minimum of two working days of notice to the Inspector and four working days of notice to the Project Manager that the installation is ready for inspection.
3. All concealed work shall be inspected before it is covered:
 - a. Underground conduit stub-ups, conduit banks and risers before the conduits are covered.
 - b. Conduit in slabs, walls and ceilings, complete with boxes.
 - c. Wire megger testing
 - d. Grounding resistivity testing
4. Electrical equipment and materials may be inspected upon arrival by the Project Manager for compliance with specifications.

1.04 SITE CONDITIONS

- A. Take the following site conditions into consideration when fabricating, erecting, installing and wiring electrical equipment under this contract:

- | | |
|----------------------------|--|
| 1. Facility Location | <u>Holiday Marina On Lake Tawakoni</u>
<u>Wills Point, Texas Van Zandt County</u> |
| 2. Plant Type and Size | <u>Lakeside Boat Launch, Restroom and Pavilion</u> |
| 3. Plant Site Elevation | <u>440 ft MSL</u> |
| 4. Seismic Zone | <u>Zone 0</u> |
| 5. Wind Velocity | <u>90 mph</u> |
| 6. Temperature, Min./Max.: | |
| • Coldest Winter Month | High <u>60</u> degrees F Low <u>41</u> degrees F |
| • Warmest Summer Month | High <u>94</u> degrees F Low <u>73</u> degrees F |
| • Lowest Expected | <u>11</u> degrees F |

- Highest Expected 105 degrees F
7. Rainfall:
- Annual 45 inches
 - Design 3.4 inches/hour, 8.4 inches/24 hours
8. Design Relative Humidity: 98%
9. Station Barometric Pressure: 29.92 in. Hg
- Average Annual 45 inches.
10. Utility Water Systems: Design Pressure Design Temp.
- River Water _____ PSI _____ degrees F
 - Well Water _____ PSI _____ degrees F
 - City Water _____ PSI _____ degrees F
11. Electric Power Supply Characteristics (Two Services Required To Be Provided By Contractor):

	Voltage	Phase	Hz	Wire	Delta or Wye
1	208/120	3	60	4	Wye
2					
3					

All charges relating to the acquisition of the electrical services for the project including permitting, fees, coordination of the dates of installation, coordination and inspections by Oncor Electric, etc. shall be paid for as a reimbursable cost without markup out of the Electrical Service Bid Allowance noted on the Bid Proposal. Construction of all the electrical service-related requirements (underground conduit banks, above ground conduit, transformer poles, meter cans, bollards, etc.) shall be included as a part of the Bidding Contractor's Bid - not out of the Bid Allowance noted in the Bid Proposal.

PART 2 PRODUCTS

2.01 COMPONENT DESIGN

- A. Components utilized in the construction of the material or equipment shall be of the latest proven design, new and in current production. Do not use obsolete components or components to be phased out of production.

2.02 FACTORY INSPECTION

- A. Always provide free access without prior notice for the Project Manager to the shop where the material or equipment are being fabricated or tested. Provide reasonable facilities for inspection, witnessing tests, and examining records. Give 7-days notice prior to starting tests which are scheduled for factory or field inspection.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify dimensions and ratings of equipment and materials to ensure proper fit and performance.

3.02 INSTALLATION

- A. Install equipment and materials in accordance with the Bid Documents and manufacturer's written instructions. If field conditions necessitate changes in electrical installation, obtain approval from the Engineer prior to initiating the change.

3.03 DEMONSTRATION

- A. Test the electrical system to specification requirements and to demonstrate correct installation and operation of all associated equipment.
- B. Initially demonstrate the system to the Project Manager. Show the system to be fully operational. All alarms, safeties, and communication points to central and local points shall operate in both fully automatic and back-up modes.

END OF SECTION 16010

PART 1 G E N E R A L

1.01 SECTION INCLUDES

- A. Conduit, fittings, and bodies.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):

1. ANSI C 80.1 - Rigid Steel Conduit - Zinc Coated.
2. ANSI C 80.4 - Fittings for Rigid Metal Conduit.

- B. Federal Specifications:

1. W-C-58 C - Conduit Outlet Boxes, Bodies Aluminum and Malleable Iron.
2. W-C-1094 - Conduit and Conduit Fittings Plastic, Rigid.
3. WW-C-566 C - Flexible Metal Conduit.
4. WW-C-581 D - Coatings on Steel Conduit.

- C. National Electrical Manufacturers Association (NEMA):

1. NEMA RN 1 - Polyvinyl-Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing.
2. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
3. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

- D. National Fire Protection Association (NFPA), ANSI/NFPA 70 - National Electrical Code (NEC).

- E. Underwriters' Laboratories (UL):

1. UL 1 - Flexible Metal Electrical Conduit.
2. UL 6 - Rigid Metal Electrical Conduit.
3. UL 514 B - Fittings for Conduit and Outlet Boxes.

4. UL 651 - Schedule 80 Rigid PVC Conduit.
 5. UL 651 A - Type EB and A Rigid PVC Conduit and HDPE Conduit.
 6. UL 886 - Electrical Outlet Boxes and Fittings for Use in Hazardous Locations.
- F. 2011 National Electrical Code

1.03 SUBMITTALS

- A. Make submittals following Section 01330 - Submittal Procedures:
1. Manufacturer's cut sheets, catalog data.
 2. Installation, terminating and splicing procedure.
 3. Instruction for handling and storage.
 4. Dimensions and weight of products.
 5. Code compliance certificates.
 6. Conformance certificate.

1.04 QUALITY ASSURANCE

- A. Rigid steel conduit shall pass the bending, ductility, and thickness of zinc coating tests described by ANSI C 80.1.
- B. Flexible conduit shall pass the tension, flexibility, impact, and zinc coating test described by UL 1.
- C. Nonmetallic conduit and fittings shall pass the test requirements of NEMA TC 2, UL 651 and 651 A and Federal Specification W-C-1094 A.

1.05 DELIVERY STORAGE AND HANDLING

- A. Package conduit in 10-foot bundles maximum with conduit and coupling thread protectors suitable for indoor and outdoor storage. Package fittings in manufacturer's standard quantities and packaging suitable for indoor storage. Package plastic-coated rigid conduit, fittings, and bodies in such a manner as to protect the coating from damage during shipment and storage.
- B. Store conduit above ground on racks to prevent corrosion and entrance of debris.
- C. Protect plastic conduit from sunlight.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Rigid Steel Conduit:
 - 1. Allied Tube and Conduit.
 - 2. Triangle Wire and Cable, Inc.
 - 3. Wheatland Tube Company.
- B. PVC Coated Steel Conduit:
 - 1. Occidental Coating Company (O-Cal Blue).
 - 2. Robroy Industries, Inc.
 - a. Rob-Roy Red
 - b. Plasti-Bond Red
 - c. Perma-Cote Green
- C. PVC Rigid Conduit:
 - 1. Cantex.
 - 2. Carlon Industries, Inc.

D. Conduit Fittings and Bodies:

1. Appleton Electric.
2. Crouse-Hinds.
3. Killark Electric Manufacturing Company.
4. O-Z/Gedney.

E. Liquidtight Flexible Conduit:

1. Anamet, Inc.
2. Electriflex Company.
3. Triangle Wire and Cable, Inc.

2.02 MATERIALS AND EQUIPMENT

A. Design Conditions. Use electrical conduit, fittings, and bodies designed for service in areas as specified in Section 16010 - Basic Electrical Requirements and this section to form a continuous support system for power, control, and instrument cables or any combination thereof.

B. Conduit and Fittings:

1. Rigid Steel Conduit and Fittings.
 - a. Rigid steel conduit and rigid steel conduit bends, nipples, and bodies shall be hot-dipped galvanized and shall comply with the latest ANSI C 80.1, UL 6, Federal Specification WW-C-581 D, and NEC Article 346-15.
 - b. Mild steel tubing shall be used for conduit, nipples, and couplings, and shall be free of defects on both the inner and outer surfaces.
 - c. Fittings and bodies and covers for rigid steel conduit shall be steel or cast-iron and shall comply with ANSI C 80.4, UL 514 B, and Federal Specification W-C-58 C. All fittings shall be Form 8. All covers for conduit fittings shall be attached using stainless steel screws. Wedge fitting type conduit covers shall not be used.

2. PVC-Coated Rigid Steel Conduit and Fittings
 - a. PVC-coated conduit, fittings, bodies, and covers shall conform to NEMA RN 1 (Type A). Rigid steel galvanized conduit and fittings shall conform to Federal Specifications WW-C-581 D and ANSI C 80.1. PVC-coated rigid metal conduit must be UL listed with PVC as the primary corrosion protection. Conduit bodies shall conform to UL 514 B and Federal Specification W-C-58 C. PVC-coated fittings for general service locations must be UL listed with the PVC as the primary corrosion protection. Provide sufficient coating for touch-up after installation.
 - b. PVC-coated couplings shall be of the ribbed type.
 - c. Condulet covers shall have encapsulated stainless steel thumb screws – no wedge clip type closures.
 - d. Condulets and covers shall be of malleable iron or ferroalloy material before coating. All fittings shall be Form 8. All covers shall be attached as required for rigid galvanized steel conduit.
 - e. Urethane coating shall be a minimum of 2 mil thickness on the interior of the conduit and the interior of fittings, condulets, covers, and bodies.
3. Flexible and Liquidtight Flexible Metal Conduit and Fittings
 - a. Use liquidtight flexible metal conduit manufactured in accordance with UL 1 and Federal specification WW-C-566 C.
 - b. Fittings used with liquidtight flexible metal conduit shall be the PVC-coated type. Thoroughly ground the conduit to the fittings and through the fittings to the box or enclosure to which it is attached.
 - c. Flexible couplings and fittings for use in hazardous areas shall comply with UL 886, NEC Article 501-4 (a&b), and Federal Specification W-C-586 C.
4. PVC Conduit and Fittings. Use PVC conduit, bends, and fittings, which comply with NEMA TC 2, W-C-A, and NBC Article 347-17 for above ground and underground installation. Conduit shall be Schedule 40 in the horizontal runs of underground conduit banks.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ensure that the conduit system to be installed is sized properly for the cable and wire requirements.
- B. Verify the actual physical conduit route from the conduit plan drawings and prepare the conduit support system.
- C. Verify the equipment locations to which the conduit will be connected and determine detail requirements for connections.

3.02 INSTALLATION

- A. Install rigid galvanized steel conduit and fittings in all outdoor locations, inside valve vaults and wet wells, lift station drypits, areas that are not air-conditioned, and in all other corrosive and wet environments, except as noted otherwise. Install PVC-coated conduit in strict accordance with manufacturer's instructions. Use installers certified by the manufacturer.
- B. Install PVC conduits in reinforced duct banks or encased in concrete slabs (Schedule 40).
- C. Install PVC coated rigid galvanized steel conduit for all underground bends greater than thirty (30) degrees, all vertical risers from the underground conduit bank to above grade, all spare conduit extensions, and all conduit penetrations through finished grade, concrete slabs, concrete sidewalks, etc. This PVC coated rigid galvanized steel conduit shall extend no less than one (1) foot above finished grade or the top of concrete. All such concrete extensions above grade or above top of concrete shall be fitted with a concrete curb extending six (6) inches above finished grade or top of concrete.
- D. Run exposed conduit parallel or perpendicular to walls, ceilings or main structural members. Group multiple conduits together where possible. Conduit shall not interfere with the use of passageways, doorways, overhead cranes, monorails, equipment removal areas or working areas. In no case shall conduit routing present a safety hazard, trip hazard, or interfere with normal plant operating and maintenance procedures. A minimum overhead clearance of 8 feet shall be maintained in passageways. All conduits installed across walkways shall have concrete or aluminum trip plates installed.
- E. Installation and support of conduit shall be from steel or concrete structures in accordance with the standard detail drawings. Furnish necessary conduit straps, clamps, fittings and support for the conduit in accordance with the standard details.
- F. Identify conduit at termination points like MCC, light fixtures, control panels, receptacles, panels, and junction boxes.

- G. Not more than 3 equivalent 90 degree bends will be permitted between outlets. Provide bonded expansion fittings at building expansion joints.
- H. Install conduit runs so that they are mechanically secure, mechanically protected from physical harm, electrically continuous, and neat in appearance. The interiors of conduit shall provide clean, smooth raceways through which conductors may be drawn without damage to the insulation. Make threaded connections wrench tight.
- I. Cut conduit square with a power saw or a rotary type conduit cutter designed to leave a flat face. Do not use plumbing pipe cutters for cutting conduit. Ream the cut ends of conduit with a reamer, designed for the purpose to eliminate rough edges and burrs. Threads shall be cut with standard conduit dies providing 3/4-inch taper per foot, allowing the proper length so that joints and terminals may be made up tight and the ends of the conduit not deformed. Keep dies sharp and use a good quality threading oil continuously during the threading operation. Remove metal cuttings and oil from the conduit ends after the threads are cut and paint threads before connections are made. Use non-corrosive Carbozinc No. 11 as manufactured by the Carboline Company, coal tar enamel or zinc rich epoxy primer on the threads of steel conduit before connections are made.
- J. Use strap wrenches only to tighten joints in plastic coated rigid steel conduit. Replace all conduit and fittings with damage to the plastic coating, such as cuts, nicks and threader chuck jaw marks. Use a solvent, or the same patching material to seal around the edges of conduit fitting sleeves.
- K. Make up changes in direction of conduit using elbows or fittings. Do not use pull boxes to make direction changes unless specifically designated otherwise.
- L. Field fabricated bends shall be free of indentations or elliptical sections. The radius of the bend shall not be less than 12 times the smallest diameter of the raceway.
- M. Protect all conduit terminations from mechanical injury. Prevent the entry of moisture and foreign matter into the conduit system by properly capping terminations.
- N. Avoid trapped runs of conduit, if possible. When they are necessary, provide drainage using a "tee" conduit equipped with a drain. Conduit is likely to pass through areas with a temperature differential of 20 F or more. Seal penetrations with a proper seal fitting at the wall or barrier between such areas. For conduit passing through walls separating pressurized areas from non-pressurized areas, install sealing fittings at the wall on the non-pressurized side.
- O. Fit all conduit crossing building or structure expansion joints with approved expansion fittings, except that fittings will not be required when conduit crossing an expansion joint is supported on trapeze hangers in such a way that at no time will the conduit be under stress due to expansion. Install bonding jumpers around expansion joint fittings.

- P. Where conduit terminates in sheet metal enclosures and where no threaded hubs are provided, fit the conduit with hubs such as manufactured by Myers. All hubs of this nature shall be equipped with auxiliary grounding lugs. These grounding lugs shall be interconnected to the facility grounding system through a dedicated wiring connection. Sheet metal enclosures made of stainless steel or aluminum located outside or in any other wet, damp, or corrosive areas shall be furnished with PVC-coated threaded hubs. Restrict side penetrations to the lower one third of the enclosure.
- Q. Provide flexible liquidtight metallic conduit where necessary to allow for movement or to localize sound or vibration, at transformers, at motors and any other rotating equipment. Flexible metal conduit shall be used as fixture whips only inside an air conditioned building.
- R. Seal all openings or holes where conduits pass through walls or floors. When passing through a firewall or floor, use a fire-rated seal per the typical detail included in the Drawings. Certain walls, as indicated on the drawings, require environmental (air-tight) seals; seal as indicated on the Drawings.
- S. Install explosion-proof seals in conduit runs crossing or entering a hazardous classified area (as shown on Drawings). Install type CSBE removable sealing fittings to seal pump cables between wet well and first junction box. If a junction box is not used, install the CSBE seals at the wet well and the control panel.
- T. Unless otherwise indicated on Drawings install expansion fittings every 300 feet within a straight conduit run and where conduit crosses building expansion joints, using bonding straps to ensure grounding continuity.
- U. Parallel runs of conduit may be supported by structural steel racks. When two or more racks are arranged one above the other, provide vertical separation of not less than 12 inches between racks, unless otherwise indicated on Drawings. Space conduits on the racks at least enough to provide 1/4-inch clearance between hubs on adjacent conduits at terminations and to allow room for fittings.
- V. Fill conduit racks no more than 75 percent of their capacity, providing usable space for future conduit. To ensure this, conduits leaving the rack horizontally shall be offset up or down so that future conduits may be installed in the space remaining. Construct conduit racks to permit access for wire or cable pulling at all pull points, even when future conduits are added to fill the racks.
- W. Where conduit racks are supported on rods from beam clamps or by some other non-rigid suspension system, install rigid supports at no more than 50-foot intervals to give lateral stability to the rack.
- X. Conduit racks or hangers must in no way interfere with machinery (or its operation), piping, structural members, process equipment, or access to anticipated future equipment. Refer to architectural, structural, equipment layout and piping drawings to ensure that

- this requirement is met. Label high voltage conduit with the circuit phase-to-phase voltage by means of a firmly attached tag or label of approved design at each conduit termination, on each side of walls or barriers pierced and at intervals not exceeding 200 feet along the entire length of the conduit.
- Y. Support conduit sizes 2 inches and larger at spacings not exceeding 10 feet and conduit sizes 1-1/2 inches and smaller at spacings not exceeding 8 feet.
- Z. The means of fastening conduit to supports shall be: by one hole malleable iron conduit straps secured by wood screws to wood and by bolts with expansion anchors to concrete or masonry; by "Korn" clamps or U-bolts to other surfaces. Use "clamp backs" when strapping conduits to walls, column faces, or other such surfaces.
- AA. Support conduit runs with conduit clamps, hangers, straps and metal framing channel attached to structural steel members. Conduits of 1-1/2 inch size or less may be supported by one-hole conduit straps on concrete, tile or steel work, but for larger size conduit, 2-hole straps shall be used. Use clamps of galvanized malleable iron for rigid galvanized conduit and stainless steel for PVC-coated conduit. Metal framing channel straps used for PVC-coated conduit shall be stainless steel.
- BB. Install conduits supported form building walls with at least 1/4-inch clearance from the wall to prevent the accumulation of dirt and moisture behind conduit..

END OF SECTION 16111

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specifications for 600-volt power and control cable.

1.02 REFERENCES

- A. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA 70 - National Electrical Code (NEC), Article 310 - Conductors for General Wiring
- B. Underwriter's Laboratories (UL)
 - 1. UL 83: Thermoplastic Insulated Wires and Cables
 - 2. UL 1063: Machine Tool Wires and Cables
- C. American Society for Testing and Materials (ASTM)
 - 1. ASTM B 3: Soft or Annealed Copper Wires
 - 2. ASTM B 8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft
- D. Insulated Cable Engineers Association (ICEA), ICEA S-61-402: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5)

1.03 SUBMITTALS

- A. Make submittals following Section 01330 - Submittal Procedures.
 - 1. Manufacturer's cut sheets, catalog data
 - 2. Instruction for handling and storage
 - 3. Dimensions and weight
 - 4. Conformance certificate

1.04 QUALITY ASSURANCE

- A. Tests. Cable shall meet all the requirements of Part 6 of ICEA S-61-402.

- B. Conformance Certificate and Quality Assurance Release: Submit a conformance certificate signed by the person responsible for product quality. The certificate shall specifically identify the purchased material or equipment; such as by the project name and location, purchase order number, supplements, and item number where applicable, including materials and services provided by others. The certificate shall indicate that requirements have been met and identify any approved deviations.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Ship wire and cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by using manufacturer's standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. American Insulated Wire Corporation
- B. Carol Cable Company, Inc.
- C. General Cable Company
- D. Okonite Company
- E. Rome Cable Company
- F. Triangle Wire and Cable, Inc.

2.02 MATERIALS AND EQUIPMENT

- A. Design. Provide cable designated as THWN/THHN or XHHW single conductor type and UL 83 and UL 1063 listed, rated 600 volts and certified for continuous operation at maximum conductor temperature of 90 C in dry locations and 75 C in wet locations while installed above ground in conduit or in control panels.
- B. Conductors. Provide conductors which are Class B, concentric stranded, annealed uncoated copper with physical and electrical properties complying with ASTM B 3 and ASTM B 8 and Part 2 of ICEA S-61-402.
- C. Insulation. Each conductor shall be PVC insulated and nylon jacketed to meet the requirements of Part 3 of ICEA S-61-402. The insulation thickness shall match the

dimensions listed in Table 310-13 of the National Electrical Code (NEC) for type THHN and THWN wire.

D. Wire Marking

1. Wire marking shall be in accordance with National Electrical Code (NEC) Article 310-11 and shall be printed on the wire insulation at 2-foot intervals.
2. The printing method used shall be permanent and the color shall sharply contrast with the jacket color.

E. The single conductor color coding shall be as follows:

<u>System Voltage</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Neutral</u>
120/208 Volt 3Ph/4w	Black	Red	Blue.....	White
120/240 Volt 3Ph/4w	Black	Orange.....	Blue	White
277/480 Volt 3Ph/4w	Brown.....	Purple	Yellow	Grey
Motor Control	1.....	Black		
	2	Red		
	3	Blue		
Ground.....				Green

PART 3 EXECUTION

3.01 PREPARATION

- A. Complete the cable raceway systems and underground duct banks before installing cables.
- B. Verify sizing of raceways and pullboxes to ensure proper accommodation for the cables.
- C. Check the length of the cable raceway system against the length of cable on the selected reel.
- D. Clean conduits of foreign matter before cables are pulled.

3.02 INSTALLATION

A. Wiring Methods

- 1. Use wiring methods indicated on Drawings.
- 2. In general, use THHN/THWN or XHHW building wire for lighting, power and control wiring where conductors are enclosed in raceways in above ground conduit system.
- 3. Do not use solid conductors.
- 4. Use conductors not smaller than No. 12 AWG stranded for power and lighting circuits.
- 5. Use conductors not smaller than No. 14 AWG for control circuits.
- 6. Do not splice conductors.
- 7. Splices associated with taps for lighting and control circuits are allowed without approval as long as they are above elevation 12 MSL.
- 8. Make splices only in accessible junction boxes.
- 9. Use wire nuts with insulated caps for lighting wiring splices.

B. Single Conductor in Conduit and Ductbank

- 1. Install cables in accordance with the manufacturer's instructions and the National Electrical Code (NEC), Chapter 3 - Wiring Methods and Materials. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.

2. Pull cables into conduits using wire pulling compounds approved by cable manufacturers to reduce friction. Lubricants must not be harmful to the conductor insulation. Mixtures containing soap or detergent shall not be used.
- C. Single Conductor in Cable Tray
1. Do not install single conductor building wire and cable in cable tray.
 2. For single conductor tray installation, see Section 16122 - 600 Volt Power Cable.
- D. Preparation for Termination
1. Make 600-volt power cable terminations and splices with heat shrinkable sleeves and seals.
 2. Terminal lugs and connectors for all sizes of conductors shall be crimp-on type.
 3. For size 1/0 AWG and larger, crimp-on lugs shall have the long barrel with 2-hole tongues except in places where termination space is limited.
- E. Tests
1. In general, megger test insulation integrity of the wiring system before terminating. All testing results shall be submitted for approval.
 2. Make sure to disconnect sensitive electronic equipment before testing insulation.
 3. Use a 500 VDC megohmmeter and perform the wire system insulation test in accordance with the operating instructions.
- F. Termination. After the 600-volt wiring system has been tested with satisfactory results, reconnect wire.

END OF SECTION 16120

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specifications for instrumentation cable.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM).
 - 1. ASTM B3: Soft or Annealed Copper Wires.
 - 2. ASTM B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft.
 - 3. ASTM B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.
- B. Institute of Electrical and Electronics Engineers (IEEE), IEEE 383-2.5: IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.
- C. Insulated Cable Engineers Association (ICEA).
 - 1. ICEA S-61-402: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-5).
 - 2. ICEA S-66-524: Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-7).
 - 3. ICEA S-68-516: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC-8).
- D. Underwriters' Laboratories (UL).
 - 1. UL 44: Rubber Insulated Wires and Cables.
 - 2. UL 83: Thermoplastic Insulated Wire and Cables.

- E. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA No. 70 - National Electrical Code (NEC), Chapter No. 3 - Wiring Methods and Materials, Article 725 - Class 1, Class 2, and Class 3 Remote Control, Signaling, and Power-Limited Circuits.

1.03 SUBMITTALS

- A. Submit the following under the provisions of Section 01330 – Submittal Procedures:

1. Completed engineer's data sheets from this specification or manufacturer's data sheets, cut sheets, and catalog data.
2. Installation, terminating and splicing procedure (including bending radius and pulling tension data).
3. Instruction for handling and storage.
4. Dimensions and weight.

1.04 QUALITY ASSURANCE

- A. Tests

Cable shall be tested at the factory to confirm that the cable complies with requirements of ICEA Section 7.7.9 of S-66-524 or 7.5.9 of S-68-516. Refer to data sheet for additional test requirements.

Where applicable, the cable shall meet the requirements of the vertical tray flame test as described in IEEE 383-2.5.

1.05 DELIVERY, STORAGE AND HANDLING

Ship cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Reels shall be of the type specified on the data sheets. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Provide moisture protection by manufacturer's standard procedure or heat shrinkable self-sealing end caps applied to both ends of the cable.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Alpha Wire Corporation

Belden Division, Cooper Industries, Inc.

Cablec Continental Cables Company

General Cable Company

Manhattan Electric Cable Corporation

Okonite Company

2.02 MATERIALS AND EQUIPMENT

- A. Design. Provide cable with the following design characteristics. The cable shall consist of multiple conductors. The cable assembly shall be UL listed, flame, oil and sunlight resistant, and certified for continuous operation at the temperature specified on the Instrumentation Cable Data Sheets in wet or dry locations while installed in underground duct, conduit, or cable tray. The number and size of conductors supplied in each cable shall correspond to the quantities specified on the Instrumentation Cable Data Sheets. Each conductor shall be individually insulated. Pairs and triads shall have conductors which are twisted together with a drain wire, shielded, and covered with a jacket. Multi-pair/triad cables shall consist of the required number of electrically isolated, shielded pairs or triads, which are bundled together and covered by an overall jacket as specified on the Instrumentation Cable Data Sheets.
- B. Conductors. Provide conductors which are Class B, concentric stranded, annealed tinned copper whose physical and electrical properties comply with ASTM B3, B8 or B33 and Part 2 of ICEA S-61-402, S-66-524, or S-68-516, unless otherwise specified on the Instrumentation Cable Data Sheets.
- C. Insulation. Each conductor shall be insulated as specified on the Instrumentation Cable Data Sheets in compliance the requirements of Part 3 of ICEA S-61-402, S-66-524, or S-68-516. The average insulation thickness shall not be less than the dimensions shown in Table 7-32 or 7.5.1 of ICEA S-66-524 or S-68-516 for 600-volt insulation unless otherwise specified on the Instrumentation Cable Data Sheets. The minimum insulation thickness shall not be less than 90 percent of the value given in the table.
- D. Drain Wire. Provide drain wire which is Class B, seven-stranded, tin-coated copper in accordance with ASTM B3, B8, or B33 and as specified on the Instrumentation Cable Data Sheets. The drain wire shall not be less than two AWG sizes smaller than the

- insulated conductor's size, except for multiple pair triad drain wires, which shall not be less than the insulated conductor size.
- E. **Shielding.** Provide shielding consisting of laminated, nonburning, mylar-backed aluminum tape applied helically around a twisted pair or triad with the aluminum side in continuous contact with the drain wire unless otherwise specified on the Instrumentation Cable Data Sheet. Wrap the tape around each twisted pair or triad with a 25 percent minimum overlap unless otherwise specified on the Instrumentation Cable Data Sheets.
 - F. **Jacket.** The physical and electrical properties of the jacket used to cover single or multi-pair or triad cables shall meet the requirements of section 7.7.7 or ICEA S-66-524 or section 7.5.6 of ICEA S-68-516. Jacket material is specified on the Instrumentation Cable Data Sheets. The jacket thickness shall be equal to the dimensions shown in Table 7-33 or 7.5.2 of ICEA S-66-524 or S-68-516. The jacket material is specified on the Instrumentation Cable Data Sheets. The jacket thickness shall be equal to the dimensions shown in Table 7-33 or 7.5.2 of ICEA S-66-524 or S-68-516.
 - G. **Armor.** Where requested, use instrumentation cables protected by an interlocked metal tape armor coating made of galvanized steel which meets the requirements of paragraph 4.5 of ICEA S-68-516 or S-66-524, unless otherwise specified on the Instrumentation Cable Data Sheets.
 - H. **Conductor Identification.** Use individual conductors in single-pair and single-triad cables which are color coded black and white; and black, white and red, respectively. Multi-pair-triad cables shall have one conductor in each pair or triad colored white, and all other conductors are color coded in sequence according to Table L-2 of Appendix 2 of ICEA S-66-524, and as specified on the Instrumentation Cable Data Sheets.
 - I. **Cable Marking.** Print cable marking information on the jacket of each cable at 2-foot intervals. Use a permanent printing method with color sharply contrasting the jacket color. See the Instrumentation Cable Data Sheets for the minimum information required.

PART 3 EXECUTION

3.01 PREPARATION

- A. Complete cable raceway systems, underground duct banks and cable support systems before installing cables.
- B. Verify sizing of raceways and pullboxes to ensure proper accommodation for the cables.
- C. Check the length of the cable raceway system against the length of cable on the selected reel.

- D. Do not install or work on PVC insulated or jacketed cables in temperatures below 32 degrees F.
- E. Clean conduits of foreign matter before cables are pulled.
- F. Provide at least 30 percent spare conductors or pairs.

3.02 INSTALLATION

A. Cable in Conduit and Ductbank

- 1. Install cables in accordance with the manufacturer's instructions and NEC Article 725 - Class 1, Class 2, and Class 3 Remote Control, Signaling and Power Limited Circuits. Do not exceed maximum wire tension, maximum insulation pressure and minimum bending radius.
- 2. Pull cables into conduits using adequate lubrication to reduce friction. Lubricants must not be harmful to the conductor insulation or cable jacket.

B. Cable in Tray. Install instrument and signal cable in cable tray only when the tray is dedicated for this type cable and cables are approved for tray installation.

C. Termination

- 1. Do not splice conductors. For termination use crimp-on type ring tongue non-insulated tin plated copper lugs.
- 2. For shielded control cable, terminate the shield and ground it at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables.
- 3. If splicing is required, maintain shield continuity by jumpering the ground shield across connection point where it is broken at junction boxes, or other splice points. Insulate these points from ground.
- 4. Mark wiring on both ends with circuit numbers or loop tag numbers. Heat shrink wire markers after the ring tongue terminal has been installed. Extend the marker over the crimp or base of the terminal.

D. Tests

- 1. Before connecting the cables, test insulation integrity and conductor continuity.
- 2. Use a 500 VDC megohmmeter and perform the cable insulation test in accordance with the operating instructions.

- E. Termination. After the 600-volt cable has been tested with satisfactory results, the cable can be terminated at both ends to their designated terminal points.

END OF SECTION 16126

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specifications for device, pull, terminal and junction boxes and wireways.

1.02 REFERENCES

- A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA).
 - 1. FB1 - Fittings and Support for Conduits and Cable Assemblies
 - 2. 250 - Enclosures for Electrical Equipment (1000 volts maximum)
- B. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA70 - National Electrical Code (NEC) - Article 370 - Outlet Device, Pull and Junction Boxes, Conduit Bodies and Fittings.
- C. Underwriters Laboratories (UL):
 - 1. 50 - Safety Cabinets and Boxes
 - 2. 508 - Safety Industrial Control Equipment
 - 3. 514B - Safety Fittings for Conduit and Outlet Boxes
 - 4. 886 - Safety Outlet Boxes and Fittings for Use in Hazardous Areas

1.03 SUBMITTALS

- A. Submit the following under provisions of Section 01330 – Submittal Procedures:
 - 1. Manufacturer's cut sheets, catalog data
 - 2. Instruction for handling and storage
 - 3. Installation instructions
 - 4. Dimensions and weights

1.04 DELIVERY, STORAGE AND HANDLING

- A. Pack and crate boxes to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Sheet Metal Boxes

1. Hoffman Industrial Products
2. Pauluhn Electric Manufacturing Company
3. Hennessy
4. Tanco
5. Tejas
6. Circle A.W.

2.02 MATERIALS AND EQUIPMENT

A. Sheet Metal Boxes

1. Provide UL-approved junction and pull boxes and wireways manufactured from stainless steel sheet metal and meeting requirements of NEMA 4X for all areas.
2. Provide enclosures with a stainless steel continuous hinge, spring loaded closure hasps and all-stainless steel hardware. All seams shall be welded and ground smooth. No sealant of any nature may be used to achieve compliance.
3. Furnish the door with neoprene gasket and provision for padlock.

B. Hardware

1. Mounting Hardware: 316 stainless steel
2. Conduit Connectors: Watertight as manufactured by Myers Hubs, or equal. All such conduit connections to sheet metal enclosures of any nature shall be equipped with such hubs. All such hubs shall be equipped with auxiliary grounding lugs that are securely interconnected to the facility grounding system.

PART 3 EXECUTION

3.01 PREPARATION

- A. Review the drawings and determine how many boxes of each kind are required and check if supplied quantity is sufficient.

3.02 INSTALLATION

- A. Boxes described in this specification shall be used both in dry and wet, corrosive areas, both inside and outside locations.
- B. Install boxes in accordance with NEC Article 370 in locations indicated on the Drawings.
- C. Install all boxes in readily accessible places to facilitate wire pulls, maintenance and repair.
- D. Plug unused conduit openings.
- E. Make conduit connections to sheet metal boxes with watertight conduit connectors.
- F. Label boxes with phenolic nameplates attached with stainless steel screws.

END OF SECTION 16131

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Specifications for wiring devices including:

1. Receptacles.
2. Wall switches.
3. Wall plates and cover plates.

1.02 REFERENCES

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA):

1. NEMA WD1 - General Purpose Wiring Devices.
2. NEMA WD6 - Dimensional Requirements.

B. Federal Specifications (WC-596F).

C. American National Standards Institute/National Fire Protection Association (NFPA):

1. NFPA No. 70 - National Electrical Code (NEC), Articles 210 Branch Circuits, 250 Grounding and 410, Paragraphs 56, 57 and 58.

1.03 SUBMITTALS

A. Submit the following under provisions of Section 01330 – Submittal Procedures:

1. Product Data: Manufacturer's product literature and specifications including dimensions, weights, certifications and instructions for handling, storage and installation.

1.04 DELIVERY, STORAGE AND HANDLING

A. Pack and crate devices to permit ease of handling and protect from damage during shipping, handling and storage.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Bryant Electric
- B. Crouse-Hinds, Arrow Hart Division
- C. Hubbel Inc. Wiring Devices Division
- D. Leviton Manufacturing Company
- E. Pass & Seymour/Legrand.

2.02 MATERIALS AND EQUIPMENT

- A. Standards: Conform to NEMA WD1 for general requirements and NEMA WD6 for dimensional requirements.
- B. Manufacture devices to heavy-duty industrial specification grade with brown nylon bodies (orange for isolated-ground receptacles) back and side wiring provisions and green-colored grounding screws.
- C. Receptacles:
 - 1. Duplex-type receptacles: Rated 20 amps at 120 volts.
 - 2. Contacts: Brass or phosphor bronze.
 - 3. Receptacle grounding system: Extend to the mounting strap unless isolated ground is indicated or required.
 - 4. GFI or GFCI (ground fault circuit interrupter) receptacles: Provide feed-through type with test and reset button.
- D. Wall Switches:
 - 1. Toggle switches: Rated 20 amps at 120/277 volts AC rated for both resistive and inductive loads.
 - 2. Contacts: Silver cadmium oxide construction to prevent sticking, welding and excessive pitting.

E. Cover Plates:

1. In outdoor, corrosive and wet areas, provide cover plates of cast metal, gasketed with spring-loaded hinged covers and stainless steel hardware.
2. All other plates: Type 316 stainless steel.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that device boxes are correctly placed.
- B. Verify that the correct quantity, size and type of wires are pulled to each device box.
- C. Verify that wiring has been checked at both ends.
- D. Prepare wire ends for connection to devices.
- E. Inspect each wiring device for defects.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install receptacles with grounding pole on top.
- E. Connect wiring device grounding terminal to outlet box with bonding jumper.
- F. Connect wiring devices by wrapping conductors clockwise around screw terminals.
- G. Install cover plates on switch, receptacle and blank outlets in finished areas.
- H. Energize and test devices for proper operation.

END OF SECTION 16140

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specifications for cabinets and enclosures for housing of control panels, motor controls and related electrical components.

1.02 REFERENCES

- A. National Electrical Manufacturers Association (NEMA).
- B. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA 70 - National Electrical Code (NEC), Article 373 - Cabinets, Cutout Box, and Meter Socket Enclosures.
- C. Underwriters Laboratories (UL), UL 50 - Safety for Cabinets and Boxes.

1.03 SUBMITTALS

- A. Submit the following under provisions of Section 01330 – Submittal Procedures:
 - 1. Manufacturer's cut sheets and catalog data
 - 2. Instruction for handling and storage
 - 3. Installation instructions
 - 4. Dimensions and weights

1.04 DELIVERY, STORAGE AND HANDLING

- A. Have cabinets and enclosures packed and crated to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. The EMF Company
- B. Hennessey Products, Inc.
- C. Hoffman Industrial Products

- D. Pauluhn Electric Manufacturing Company
- E. Weigman Company
- F. Rose Enclosure
- G. N.E.M.A. Enclosure Mfg. Co.

2.02 MATERIALS AND EQUIPMENT

A. Sheet Metal Boxes

1. Provide enclosures manufactured in accordance with NEMA 250 and NEC Article 373. Fabricate outdoor NEMA 4X enclosures from minimum 14 gauge stainless steel for all areas. Additional white painted coatings shall be provided for the main control panel and any other enclosures which contain electrical components that could be damaged by excessive heat.
2. Dimensions and special features are shown on the Drawings.
3. Construct outdoor enclosures with continuously welded seams ground smooth. No sealants of any nature may be used.
4. Additional material thickness and bracing requirements shall be determined by the manufacturer to provide the strength required by the standard listed. The bracing shall be provided in such a way as to minimize the protrusion into the wiring and the equipment spaces.
5. Install the door with a stainless steel continuous hinge, stainless steel padlock handle with gasket and stainless steel hardware.
6. Furnish the door with oil-resistant neoprene gasket attached with oil-resistant adhesive and held in place with aluminum retaining strips.
7. For large enclosures provide a single, 3/4-inch minimum, door handle that provides a 3-point latching through latch rods with rollers. Provide rollers with at least 3/4-inch diameter.
8. Gasketed overlapping doors may be used instead of a center post.
9. Provide heavy duty lifting eyes of suitable material.
10. Fabricate the enclosure with a stud-mounted panel inside. Make panels from 12-gauge steel painted with white enamel finish.
11. Weld mounting feet to the enclosure if called for on the Drawing.

12. Include a high impact plastic data pocket in the enclosure.
13. Provide ground connections on the enclosures to enable grounding of the enclosure with a No. 2 AWG conductor.
14. Equip free-standing outdoor cabinets with inner and outer door restraint bars to prevent door swing during windy conditions.

B. Hardware

1. Mounting Hardware: Stainless steel
2. Conduit Connectors: Watertight as manufactured by Myers Hubs, or equal. Provide hubs of this nature for conduit connections to all enclosures. All such hubs shall be equipped with an auxiliary grounding lug that is securely connected to the facility grounding grid.

2.03 TESTING

- A. Test cabinets and enclosures in accordance with UL requirements so unit qualifies for a UL label.

PART 3 EXECUTION

3.01 PREPARATION

- A. Review Drawings and determine how many enclosures of each kind are required and check if supplied quantity is sufficient.
- B. Check the mounting pads or foundations for proper mounting dimensions and features, including grounding conductor stub-up.

3.02 INSTALLATION

- A. Use enclosures described in this specification only above grade.
- B. Install enclosures in accordance with the NEC in locations as indicated on the Drawings.
- C. Install enclosures in readily accessible locations to facilitate general operations, wire pulls, maintenance and repair.
- D. Plug unused conduit openings.
- E. Make conduit connections to the enclosures with watertight conduit connectors.
- F. Identify all components in cabinets with phenolic nameplates.
- G. Use pre-printed tubular heat-shrink type wire and cable markers to label each end of all conductors.

END OF SECTION 16160

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specifications for disconnect switches including:
 - 1. Fusible disconnect switches
 - 2. Non-fusible disconnect switches
 - 3. Circuit breaker type disconnect switches
 - 4. Fuses
 - 5. Circuit breakers
 - 6. Manual transfer switches

1.02 REFERENCES

- A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA)
 - 1. NEMA AB1: Molded Case Circuit Breakers
 - 2. NEMA KS1: Enclosed Switches
- B. Underwriters Laboratories (UL)
 - 1. UL 98: Standard for safety enclosed switches and Dead Front Switches
 - 2. UL 198C: High Interrupting Capacity Fuses, Current Limiting type
 - 3. UL 198E: Class R Fuses
- C. American National Standards Institute/National Fire Protection Association (ANSI/NFPA), NFPA No. 70 - National Electrical Code (NEC), Article 380 - Switches.

1.03 SUBMITTALS

- A. Submit the following under provisions of Section 01330 – Submittal Procedures:
 - 1. Manufacturer's cut sheets and catalog data
 - 2. Switch internal arrangement
 - 3. Breaker or fuse characteristic curves
 - 4. Instructions for handling and storage
 - 5. Installation instructions
 - 6. Dimensions and weights

1.04 DELIVERY, STORAGE AND HANDLING

- A. Have disconnect switches packed and crated to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Disconnect Switches and Circuit Breakers:
 - 1. Cutler-Hammer Products
 - 2. General Electric
 - 3. Siemens Energy and Automation
 - 4. Square D Company
 - 5. Westinghouse Electric
- B. Fuses
 - 1. Bussman Division, Cooper Industries
 - 2. Gould Shawmut
 - 3. Littelfuse Incorporated

2.02 MATERIALS AND EQUIPMENT

A. Disconnect and Transfer Switches

1. Characteristics: Horsepower rated, 600-volt, heavy-duty type with an interlocked door, positive quick-make, quick-break mechanism and visible blades.
2. Use switches and components designed, manufactured and tested in accordance with NEMA AB1, NEMA KS1, UL 98, and NEC Article 380.
3. Enclose switch in a NEMA 4X, stainless steel enclosure in all locations. Enclosures shall have fully welded seams that are ground smooth. No sealant of any kind may be used to support the NEMA 4 classification.
4. Provide switches with provisions for padlocking the operating lever in any position.
5. Select switches having the number of poles and general size conforming to the Drawings.
6. Conform to fusible, non-fusible or circuit breaker type switch requirements as shown on Drawings and required by the NEC, or one-line diagrams.
7. Provide an auxiliary contact as shown on the Drawings.
8. Select fuses or circuit breakers with current interrupting duty as calculated for the points of switch application or as indicated on the Drawings or one-line diagrams.

B. Fuses. Unless otherwise noted on Drawings, for fuses used in disconnect switches, provide the dual-element, time-delay type with the maximum interrupting rating of 200,000 amperes, conforming to the NEC.

C. Circuit Breakers. When circuit breakers are used in disconnect switches, provide the thermal-magnetic type with current interruption ratings as required at the point of application.

D. Conduit Connectors: Watertight as manufactured by Myers Hubs, or equal. Hubs of this nature shall be used for all connections to enclosures. All such hubs shall be equipped with auxiliary grounding lugs that are securely interconnected to the facility grounding system.

PART 3 EXECUTION

3.01 PREPARATION

- A. Review the Drawings and verify that the disconnect switches are correct for the applications.
- B. Make sure that the correct fuses or breakers are being used regarding size and short circuit interrupting capability.
- C. Prepare adhesive labels on the inside door of each switch indicating UL fuse class and size or breaker type and size for replacement.

3.02 INSTALLATION

- A. Install the disconnect switches in accordance with and NEC Article 380.
- B. Mount switches 6'-6" (to top of cabinet) above finished floor or grade.
- C. In wet and corrosive areas, including outdoor locations, install switches on spacers to provide a space of approximate 1/4-inch between the back of cabinet and the mounting surface.
- D. In wet and corrosive areas, including outdoor locations, connect conduit to the bottom of enclosure and to the lower 30 percent of the sides using watertight connectors.
- E. All mounting hardware shall be stainless steel.

END OF SECTION 16165

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding electrodes and conductors
- B. Equipment grounding conductors
- C. Bonding
- D. Power system grounding
- E. Communication system grounding
- F. Electrical equipment and raceway grounding and bonding
- G. Control equipment grounding

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM B3: Soft or Annealed Copper Wires
 - 2. ASTM B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, Soft
 - 3. ASTM B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes
- B. Institute of Electrical and Electronics Engineers (IEEE)
 - 1. IEEE 142-82: Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - 2. IEEE 383-2.5: IEEE Standard for Type Test of Class IE Electric Cables, Field Splices, and Connections for Nuclear Power Generating Stations.

- C. Underwriters' Laboratories (UL)
 - 1. UL 83: Thermoplastic Insulated Wire and Cables
 - 2. UL 467: Grounding and Bonding Equipment
- D. National Fire Protection Association (NFPA), NFPA No. 70 - National Electrical Code (NEC), Article No. 250 - Grounding.

1.03 SUBMITTALS

- A. Submit the following under the provisions of Section 01330 – Submittal Procedures:
 - 1. Manufacturer's cut sheets and catalog data
 - 2. Installation, terminating and splicing procedure
 - 3. Instruction for handling and storage
 - 4. Dimensions and weight

1.04 QUALITY ASSURANCE

- A. Tests
 - 1. Use insulated cable conforming to requirements of the vertical tray flame test as described in IEEE 383-2.5.
 - 2. Test grounding system in the field in accordance with procedures outlined in Part 3 - Execution.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Ship grounding cable on manufacturer's standard reel sizes unless otherwise specified. Where cut lengths are specified, mark reel footage accordingly. Each reel shall contain one continuous length of cable. Provide impact protection by wood lagging or suitable barrier across the traverse of the reel. Pack and crate other materials specified to withstand normal abuse during shipping, handling and storage.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Cable
 - 1. American Insulated Wire Company
 - 2. Cablec Continental Cables Company
 - 3. General Cable Company
 - 4. Okonite Company
 - 5. Pirelli Cable Corporation
 - 6. Rome Cable Corporation
 - 7. Triangle Wire and Cable, Inc.
- B. Ground Rods and Connectors:
 - 1. Blackburn
 - 2. Copperweld
 - 3. Thomas & Betts
- C. Exothermic Connections:
 - 1. Burndy Corporation (Therm-O-Weld)
 - 2. Erico Products (Cadweld)
- D. Grounding Connectors:
 - 1. Burndy Corporation
 - 2. O.Z. Gedney
 - 3. Thomas & Betts

2.02 MATERIALS AND EQUIPMENT

- A. Design. Provide grounding cable and materials with the following characteristics:
1. Use a grounding system designed in accordance with NEC Article No. 250 - Grounding, and the IEEE 142-82 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- B. Materials
1. Use grounding conductors, bare underground and insulated above ground, which are manufactured and tested in accordance with applicable standards ASTM B3, ASTM B8 and ASTM B33.
 2. Provide a main ground loop of No. 4/0 AWG, Class C stranded, bare copper cable. Small groups of isolated equipment may be grounded by a No. 2 AWG minimum insulated conductor connected to the main loop. Generally, taps shall be sized as follows:

a.	Main ground loop or grid	#4/0 minimum
b.	Switchgear, motor control centers and power transformers	#4/0
c.	Motors 200 hp and above	#4/0
d.	Power panels - AC and DC	#2/0
e.	Control panels and consoles	#2
f.	Building columns	#4/0
g.	Fencing posts	#2/0
 3. Where single conductor insulated grounding conductors are called for use 600-volt insulation. Use ground conductors identified with green insulation. The use of green insulating tape is not permitted.
 4. Supply identifying ribbon which is PVC tape, 3 inches wide, red color, permanently imprinted with "CAUTION BURIED ELECTRIC LINE BELOW" in black letters as specified in Section 16195, Electrical Identification.
 5. Utilize flexible copper braid across hinged chain link or fence gates to bond the movable portion to the grounded fence post.

PART 3 EXECUTION

3.01 PREPARATION

- A. Complete site preparation and soil compaction before trenching and driving ground rods for the underground grid.
- B. Verify from Drawings the exact location of stub-up points for grounding of equipment, fences and building or steel structures.

3.02 CONSTRUCTION CRITERIA

- A. The main ground loop at a depth of at least 30 inches below earth surface. Connect the ground loop to ground rods and to tap connections to form a complete system as indicated on the electrical Drawings. The Contractor shall give special attention to the grounding of service equipment, structures and fences to comply with the NEC, local authorities and the serving utility company.
- B. All electrical equipment, buildings, tanks, and equipment shall be grounded. Where ground rods are required, the rods shall be 10 feet long, 3/4 inch diameter, copper-clad steel ground rods. Rods shall be driven vertically, and the top of the rods shall be a minimum of 18 inches below finished grade, or as specified on the Drawings. All ground rods shall be installed in specifically designed precast concrete ground rod wells that are equipped with a metal cover with the designation of GROUND on the cover.
- C. Local pushbutton and selector switch stations, two-wire control devices, disconnect switches, lighting transformers, panelboards, operator panels, benchboards, and the enclosures of other electrical apparatus shall be grounded through a power grounding conductor routing with the power conductors in the conduit and a supplemental equipment grounding conductor run independently.
- D. Motors having power supplied by multi-conductor cable shall be grounded by a separate grounding conductor in the cable and where supplied by single conductor cable in conduit by a grounding conductor pulled in the conduit. Connect ground conductors to the ground bus in the motor control center and to the ground terminal provided in the motor conduit box.
- E. Do not ground the insulated bearing pedestals of large motors.
- F. Connect ladder-type cable trays to the grounding electrode system.
- G. Install a warning ribbon approximately 12 inches below finished grade directly above the ground grid.
- H. Connect fence posts of chain link and metal fences to the main ground loop at least every 50 feet.

3.03 INSTALLATION

A. Equipment Grounding

1. Make grounding connections to surfaces which are dry and cleaned of paint, rust, oxides, scales, grease and dirt to ensure good conductivity. Clean copper and galvanized steel to remove oxide before making welds or connections.
2. Use the exothermic welding process for below-grade grounding connections, except at ground rods. Use mechanical connectors or thermal connections for above-grade grounding connections as shown on the Drawings.
3. Make grounding connections to electrical equipment, vessels, mechanical equipment and ground rods in accordance with the Drawings.
4. Ground tanks and vessels by making connections to integral structural supports or to existing grounding lugs or pads, and not to the body of the tank or vessel.
5. Leave ground connections to equipment visible for inspection. Protect them with PVC non-metallic conduit as indicated on the Drawings.
6. Make connections to motor frames and ground buses with lugs attached to the equipment by means of bolts. Do not use motor anchor bolts or equipment housing for fastening lugs of grounding cable.
7. Where the wiring for lighting systems consists of single conductor cables in conduit, provide each conduit with an equipment grounding conductor. Use a grounding conductor with green colored insulation and ground equipment in the lighting system.

B. Raceway and Support Systems Grounding

1. Install raceway, cable rack or tray and conduit so that it is bonded together and permanently grounded to the equipment ground bus, according to the Drawings. Connection to conduit may be grounding bushing or ground clamp.
2. Install raceway at low voltage motor control centers or other low voltage control equipment so that it is bonded and grounded, except that any conduit which is effectively grounded to the sheet metal enclosure by bonding bushing or hubs need not be otherwise bonded.
3. Where a grounding conductor is run in or on a cable tray, bond the grounding conductor to each section of cable tray with a cable tray ground clamp.
4. Where only grounding conductor is installed in a metal conduit, bond both ends of the conduit to the grounding conductor.

5. Provide flexible "jumpers" around raceway expansion joints. Use copper bonding straps for steel conduit. Install jumpers across cable tray joints which have been parted to allow for expansion and any hinged cable tray connections.
- C. Fences and Gates. Ground fences, fence posts and gates to the underground grid as noted in these specification and as shown on the Drawings.
- D. Power System Grounding
1. Solidly ground the secondary neutral of the main power supply transformer either to the ground grid. See Drawings for additional details.
 2. Solidly ground the neutral of lighting, instrument and control transformers.
- E. Cable Armor and Shields
1. For shielded control cable, terminate and ground the shield at one end only, preferably at the control panel end for instrument and communication cable and at the supply end for electronic power cables. Maintain shield continuity by jumpering the ground shield across connection point where it is broken at junction boxes, or other splice points. Insulate these points from ground.
 2. Connect the ground wire in power cable assemblies at each terminal point to a ground bus, if available, or to the equipment enclosure. Do not carry these ground wires through a "doughnut" current transformer (CT) used for ground fault relaying; do carry ground leads from stress cones through CTs. Ground power cable armor and shield at each terminal point.
- F. Test Wells
1. Provide access (test wells) for testing the ground grid system at one or several ground rod locations. Make test wells of a pipe surrounding the rod and connections with a cover placed on top at grade level. See Drawings for details.
 2. Install a test well at the service entrance pole to serve as the service entrance grounding electrode.

G. Test

1. Perform ground resistance tests after underground installation and connections to building steel are complete, unless otherwise noted on applicable Drawings.
2. Make tests at each and every ground tap using a "fall of potential" test method. Each ground tap test shall not exceed a maximum resistance of 3 ohms. Where measured values exceed this figure, install additional ground rods as required to reduce the resistance to the specified limit. Submit the results of all grounding testing for review and approval. All such grounding testing results shall be submitted with a drawing that illustrates the specific location of each grounding test conducted.

H. Inspection. Inspection of the grounding system by the Engineer and the local Code Inspector must take place before the grid trenches are backfilled.

END OF SECTION 16170

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Specification for electrical identification including:

1. Nameplates and labels
2. Wire and cable markers
3. Conduit markers
4. Cable tray markers
5. Underground warning tape
6. Warning labels

1.02 REFERENCES

A. American National Standards Institute/National Fire Protection Association (ANSI/NFPA)

1. No. 70 - National Electrical Code (NEC)
 - a. Article 110 - Requirements for Electrical Installation
 - b. Article 430 - Transformers and Transformer Vaults

B. Other applicable Codes and Standards as referenced in other Sections.

C. Underwriters Laboratories. U.L. Standards No. 224 - Extruded Insulated Tubing

1.03 SUBMITTALS

A. Submit the following under the provisions of Section 01330 Submittal Procedure:

1. Manufacturer's cut sheets and catalog data
2. Description of materials used
3. Label or nameplate dimensions
4. Engraving or imprint legends

5. Instruction for handling and storage

6. Installation instructions

1.04 DELIVERY, STORAGE AND HANDLING

- A. Pack materials to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Almetek Industries Incorporated
- B. Brady U.S.A. Incorporated
- C. Ideal Electric Company
- D. Raychem Corporation
- E. 3M Electrical Products Division
- F. Thomas & Betts
- G. Tyton Corporation

2.02 MATERIALS AND EQUIPMENT

- A. Nameplates and Labels
1. Provide an identification tag for each item of electrical equipment showing its item number and service or application. Use the description shown on the electrical Drawings.
 2. For nameplates, use 3-ply phenolic material engraved to show black lettering on a white background. Size the nameplates approximately 1 inch wide and 3 inches long for 3 lines of 3/16 inch - 16 letters with a 0.8 condensed factor.
 3. Generally, provide large pieces of equipment with engraved nameplates; provide additional nameplates at pushbuttons and other local devices; as detailed. Provide identification for all other electrical equipment, devices, or enclosures, such as MCC's, panelboards, disconnect switches, capacitors, relays, and dedicated receptacles not furnished with readily noticeable tag, nameplates, or other means of identification.

4. Install nameplates on the front cover of transformers stating the transformer service location number or identification number, the panelboard or device served, and main breaker feeding the transformer (MCC No. and compartment), and the drawing number on which the transformer schematic is shown.
5. Furnish equipment, such as motor starters, safety switches, welding receptacles and circuit breakers, with 1" x 3" plastic nameplates stating description of item served.
6. Provide nameplates for motors giving the driven equipment description, the service location number, and the MCC number with compartment number when applicable. Nameplates will normally be mounted adjacent to the motor at the motor pushbutton when one is furnished.
7. Install nameplates on the outside and inside of doors to circuit breaker panelboards (i.e., lighting, instrument or receptacle panels). State the panelboard name, the drawing number on which the panelboard schedule shows, and the main breaker feeding the panel (MCC No. and compartment).
8. Type panelboard directories and insert them inside the panelboard doors.
9. Place a large nameplate approximately 3"x5" on control panels, relay panels, junction boxes, or enclosures with electrical devices mounted inside or on the outside of the enclosure indicating the purpose of the cabinet.
10. Provide a nameplate on MCC motor starter doors duplicating motor nameplate data.

B. Wire and Cable Markers

1. Use pre-printed tubular heat-shrink type wire and cable markers at each end of all conductors...
2. Select markers manufactured so that the heat-shrink process makes the imprint permanent and solvent-resistant.
3. Use markers that are self-extinguishing, conforming to U.L. Standard No. 224 for print performance, heat shock, and flammability.
4. Provide marker material that is flexible, radiation cross-linked polyolefin with 3 to 1 shrink ratio, rated 600 volts, and white in color.

C. Conduit Markers

1. Provide conduit markers made of stainless steel tags approximately 2 inches x 1 inch x 19 gage.
2. Stamp the caption on the tag and have it black filled.
3. Punch tags for tie fasteners. Fasten tags to the conduits with stainless steel cable ties as manufactured by Panduit or approved equal.

D. Cable Tray Markers

1. For high visibility and contrast, use cable tray markers that are yellow with black legend.
2. Use markers made of vinyl impregnated cloth, suitable for exposure to corrosive, wet, and abrasive environment.
3. Make markers of pre-cut individual letters or numbers with pressure sensitive adhesive backing.
4. Size legend characters to 4 inches high on a total marker height of approximately 5 inches, suitable for applying to 6-inch side rails of a cable tray.

E. Underground Warning Tape

1. Provide warning tape made of 4 mil thick polyolefin film, 3 inches wide, suitable for direct burial and resistant to alkalis, acids, and other common soil substances.
2. Use red tape with black legend printed in permanent ink.

F. Warning Labels

1. Place OSHA safety labels on enclosures and boxes 100 cubic inches or more containing electrical equipment or terminations.
2. Provide OSHA color codes for the labels. Use labels made from 4 mil vinyl with pressure sensitive adhesive backing.
3. The warning label caption is DANGER - 480 VOLTS or as indicated on the Drawings
4. Size labels either 5 inches x 3-1/2 inches or 10 inches x 7 inches, as indicated on the Drawings.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces where adhesive labels will be applied.
- B. Drill holes for nameplates to be fastened with stainless screws.
- C. Prepare the cable ends for termination and conductor markings.
- D. Identify conduits at terminating points and select tags accordingly.

3.02 INSTALLATION

- A. Install nameplates and labels in accordance with the manufacturer's instructions and the Drawings.
- B. Apply wire and cable markers in accordance with manufacturer's instructions using a heat gun with properly sized nozzle for the application. Tag the wires at both ends with the same notation.
- C. Tag conduits at junction boxes, pull boxes, and at other termination points.
- D. Identify cable trays at the time of installation with the alphanumeric number shown on the Drawings. Label cable trays on the outside rail. Place the tray identifier at each point where the tray designation changes and at 200 foot intervals in between, but not less than two per run.
- E. Identify underground conduits, cables, or duct banks using the underground warning tape. The underground grounding grid, including the laterals. Also use underground warning tape. Install one tape per trench at 12 inches below grade or as indicated on the Drawings. For wide trenches or duct banks, install one warning tape per 24 inch width.
- F. Apply the 5 inches by 3-1/2 inches warning labels to disconnect switches, panelboards, terminal boxes, and similar devices in accordance with manufacturer's instruction and the Drawings. Apply the 10 inches x 7 inches warning labels to larger control panel enclosures, motor control centers, and to entrance doors to buildings containing electrical power and control equipment.

END OF SECTION 16195

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Underground electrical duct banks.

1.02 REFERENCES

- A. National Fire Protection Association (NFPA): No. 70 - National Electrical Code (NEC) Appendix B.

1.03 SUBMITTALS

- A. Catalog cut sheets of the ducts and spacers.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Have duct spacers and associated hardware packed and crated to avoid damage during shipment and handling.
- B. Clearly mark packages or crates stating that the material is for electrical duct banks only.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Thomas and Betts.
- B. Underground Devices Inc.
- C. Walker Division, Butler Manufacturing Company.

2.02 MATERIALS AND EQUIPMENT

- A. Conduit. Construct ducts using schedule 40 rigid PVC conduit. Refer to Section 16111 - Conduit, Fittings and Bodies.
- B. Spacers. Secure conduit with non-magnetic, universal, interlocking-type spacers for both horizontal and vertical duct arrangements.
- C. Concrete. Use steel reinforced, red concrete as duct encasement. Refer to Section 03100 Concrete Formwork.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify from Drawings and field survey that the location of ductbanks does not interfere with any existing or new underground facilities.
- B. Verify that materials are on site in proper condition and that sufficient quantity is on hand for the work.
- C. Verify that trenches are in the correct places and prepared with sufficient depth and width to accommodate the duct banks, reinforcing rod, and concrete.
- D. Be prepared for inspection of the duct banks before reinforcing rod is installed.
- E. Before pouring concrete, verify that the ducts are free of debris and properly installed in the support and spacer systems and that the ducts are properly fitted together and firmly held in place by the hold down hardware.
- F. Provide 24-hour notice to Project Manager and the Local Code Inspector for cover-up inspection before pouring electrical conduit ductbanks.

3.02 INSTALLATION

- A. Use the size and types of conduit as indicated on the Drawings for the various duct banks required for the project.
- B. Make duct bank installations and penetrations through foundation walls watertight.
- C. Assemble duct banks using non-magnetic saddles, spacers and separators. Position separators to provide 2-inch minimum concrete separation between the outer surfaces of the conduits.
- D. Provide a 3-inch minimum concrete covering on both sides, top and bottom of concrete envelopes around conduits. Add red dye at the rate of 10 pounds per cubic yard to concrete used for envelopes for easy identification during subsequent excavation.
- E. Firmly fix ducts in place during pouring of concrete. Carefully spade and vibrate the concrete to ensure filling of spaces between ducts.
- F. Make bends with sweeps of radius not less than 6 times the smallest diameter of the raceway.
- G. Make a transition from non-metallic to pvc-coated metallic rigid conduit where duct banks enter structures or turn upward for continuation above grade.
- H. Make bends of 30 degrees or more using rigid galvanized steel.

- I. Reinforce duct banks throughout, where indicated on the Drawings.
 - 1. Unless otherwise noted on the Drawings, reinforce with No. 5 longitudinal steel bars placed at each corner and along each face at a maximum parallel spacing of 12 inches on centers, and No. 5 tie-bars transversely placed at 18-inch maximum longitudinal intervals.
 - 2. Maintain a maximum clearance of 2 inches from bars to the edge of the concrete encasement.
- J. Where ducts enter structures such as hand holes, manholes, pull boxes, or buildings, terminate the ducts in suitable end bells, insulated L-bushings, Meyers hubs or couplings on steel conduits. Tag conduit entering pull boxes with stamped, stainless steel tags. Identify as designated in cable and conduit schedule.
- K. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials which can damage or contribute to corrosion of ducts or prevent adequate compaction of fill.
- L. Install a bare stranded copper duct bank ground in each duct bank envelope. Make ground electrically continuous throughout the entire duct bank system. Connect ground to switchgear and MCC ground buses and to steel conduit extensions of the underground duct system.
- M. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross section approximately one-fourth inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to remove any particles of earth, sand or gravel that may have been left in the duct. Repull the rag or sponge swab until the swab emerges clean.
- N. Use hemp rope to pull conductors into PVC conduit. Do not use nylon or wire cable for this purpose.
- O. Install a warning ribbon approximately 12 inches below finished grade over underground duct banks. Refer to Section 16195 - Electrical Identification.
- P. For manholes and pull boxes below grade, install wire racks to support cables properly around the perimeter and keep them dry.
- Q. For manholes and pull boxes below grade, construct a french drain, or other drainage.

END OF SECTION 16402

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specifications for dry-type transformers for the following applications:
 - 1. Motor drive isolation
 - 2. Shielded isolation
 - 3. Non-linear loads
 - 4. General purpose

1.02 REFERENCES

- A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA)
 - 1. ANSI No. C89.2: Transformers
 - 2. NEMA ST 1: Specialty Transformers
 - 3. NEMA ST-20: Dry-Type Transformers for General Applications
- B. Underwriters Laboratories (UL): UL 506 - Standard for Safety Specialty Transformers.
- C. American National Standards Institute/National Fire Protection Association (ANSI/NFPA): NFPA No. 70 -National Electrical Code (NEC); Article 450 - Transformers and Transformer Vaults.

1.03 SUBMITTALS

- A. Submit the following under provisions of Section 01330 – Submittal Procedures:
 - 1. Outline dimensions, support points and unit weight.
 - 2. Electrical characteristics, including impedance and tap configuration.
 - 3. Insulation type, rated temperature rise, and total insulation system.
 - 4. Test reports, for transformers 300 KVA and above, indicating losses at 25, 50, 75 and 100 percent rated load and sound levels.
 - 5. Connection diagrams.

6. Catalog data.
7. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Tests. Run manufacturer's test on transformers in accordance with Underwriters Laboratories (U.L.) Standard No. UL-506.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Have transformers individually packed and crated to permit ease of handling and to provide protection from damage during shipping, handling and storage.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. ACME Transformer
- B. Cutler-Hammer
- C. General Electric
- D. Hevi-Duty
- E. EATON
- F. Square D Company

2.02 MATERIALS AND EQUIPMENT

- A. Use dry-type transformers for lighting system or other general purpose applications, motor drive isolation, shielded isolation and non-linear load requirements.
- B. Provide transformers with copper windings.
- C. Select transformers designed and constructed in accordance with NEMA ST-1, NEMA ST-20 and the NEC Article 450.
- D. For applications up to 30 KVA, use transformers that are encapsulated with a non-ventilated type enclosure that will operate at their rating with 115 °C temperature rise with a 185 °C insulation class.

- E. Provide transformers with full capacity winding taps a minimum of two 2-1/2 percent above and two 2-1/2 percent below normal voltage.
- F. For applications of 30KVA and above use transformers that are of the drip-proof ventilated type for indoor and outdoor mounting. Outdoor mounted units shall be housed in NEMA 3R enclosures. Units mounted indoors shall be housed in the same type of enclosure, however, no drip shield is required. As with the transformers of lower rating these units shall similarly operate at their rating with 115 °C temperature rise with a 185 °C insulation class
- G. Use transformers with sound levels in accordance with NEMA ST-20.
- H. Basic impulse level (BIL) shall be 10KV for transformers less than 300 KVA and 30KV for transformers 300KVA and larger.
- I. Ground core and coil assembly to enclosure by means of a visible flexible copper strap.
- J. Provide transformers with lifting eye bolts or brackets.
- K. Provide transformer nameplates of stainless steel, marked in accordance with NEC Article 450-11. Fasten nameplate to the transformers with stainless steel screws or rivets.
- L. Refer to the one-line diagram or the Drawings for transformer size, volt and wire configuration.
- M. Special purpose transformers shall be as follows:
 - 1. Motor drive isolation transformers: designed for 3-phase SCR controlled, variable speed motor voltages with bracing to withstand stresses associated with motor drives.
 - 2. Shielded isolation transformers shall be designed for power inputs to microprocessors and computers that require additional protection from electrical disturbances with the use of grounded electrostatic shielding.
 - 3. Non-linear transformers shall be designed to withstand the heating effects caused by harmonics resulting from non-linear, non-sinusoidal loads. Use K-rated transformers for non-linear loads.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify dimensions of housekeeping pads or other support structures to ensure proper fit.

- B. Verify raceway and wiring drawings that are prepared for the transformers and check them against the manufacturer's information.
- C. Verify that the protective devices planned for the transformers are in accordance with NEC Article 450.

3.02 INSTALLATION

- A. Install transformers plumb and level and in accordance with manufacturer's instructions and the NEC Article 450.
- B. Use flexible conduit for connection to transformer case. Make conduit connections to side panel of enclosure.
- C. Mount transformers on isolation pads as required to isolate transformer noise from the buildings structure.
- D. Wire transformer primary and secondary in accordance with the nameplate instructions and the designated voltages as shown on the one-line diagram.

END OF SECTION 16461