

**CORPUS CHRISTI REGIONAL
TRANSPORTATION AUTHORITY**

**RFP No. 2024-FC-17
GENERATOR FOR BEAR LANE**

**SPECIFICATIONS
(EXHIBIT I)**

Prepared by
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SECTION
TABLE OF CONTENTS
SPECIFICATIONS
FOR
Bear Lane Generator

SECTION

NUMBER SPECIFICATION

00099 Table of Contents

HANSON - CIVIL SPECIFICATIONS

025223 Crushed Limestone Flexible Base
025612 Concrete Sidewalks and Driveways
025620 Portland Cement Concrete Pavement
030020 Portland Cement Concrete
032020 Reinforcing Steel
038000 Concrete Structures

HANSON - STRUCTURAL SPECIFICATIONS

01 45 00 Windstorm Construction Requirements
03 30 00 Cast-in-Place Concrete
04 23 00 Reinforced Unit Masonry
31 23 33 Structural Excavation, Backfill and Compaction

GPM-DIVISION 22 - PLUMBING

22 05 00 Basic Plumbing Requirements
22 10 00 Plumbing Piping

GPM-DIVISION 26-ELECTRICAL

26 00 10 Special Provisions for Electrical Work
26 01 10 Raceways
26 01 11 Conduit and Fittings
26 01 20 Wire and Cable 600 V and Under
26 01 31 Junction and Pull Boxes
26 06 12 Emergency Power Systems

SECTION
CIVIL TABLE OF CONTENTS
SPECIFICATIONS
FOR
BEAR LANE GENERATOR
5658 BEAR LANE CORPUS CHRISTI

SECTION

CIVIL SPECIFICATIONS

025223	Crushed Limestone Flexible Base
025612	Concrete Sidewalks and Driveways
025620	Portland Cement Concrete Pavement
030020	Portland Cement Concrete
032020	Reinforcing Steel
038000	Concrete Structures



07/17/2023

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SECTION 025223
CRUSHED LIMESTONE FLEXIBLE BASE

1. DESCRIPTION

This Specification shall govern all work for furnishing and placing Crushed Limestone Flexible Base required to complete the project.

2. MATERIAL

Crushed Limestone Flexible Base shall consist of crushed limestone produced from oversize quarried aggregate, sized by crushing and produced from a naturally occurring single source, meeting the requirements for Type 'A' material as specified in Texas Department of Transportation (TxDOT) Specification Item 247 "Flexible Base". Crushed gravel or uncrushed gravel shall not be acceptable. No blending of sources and/or additive materials will be allowed. The material shall be free of vegetation and shall be approved by the Engineer. All acceptable material shall be screened and the oversize shall be crushed and returned to the screened material in such a manner that a uniform product will be produced which meets all of the physical requirements for Grade 1-2 as specified in TxDOT Specification Item 247 "Flexible Base".

3. TESTING

The City will engage a laboratory and pay for one test each gradation, liquid limit, plasticity index, modified proctor, moisture-density relation, CBR, and necessary field densities. The Engineer may call for additional tests at any time. The cost of all retests, in case of failure to meet specifications, will be deducted from the Contractor's payment. The City will pay for proctor and soil constants and abrasion tests at the rate described in the materials testing schedule. If material changes, the Contractor shall pay the cost of additional tests required by the Engineer. The Engineer may waive testing and/or lime admix for small amounts for unimportant uses.

4. CONSTRUCTION METHODS

Prior to placement of flexible base, the surface of the previous underlying course shall be finished true to line and grade as established, and in conformity with the typical section shown on the drawings. Grade tolerance shall be generally 1/2 inch, and highs and lows must approximately balance. If called for in the drawings or elsewhere in the contract documents, geogrid, as specified in City Standard Specification Section 022040 "Street Excavation", shall be placed as indicated.

Flexible base shall be delivered and spread the same day if possible (no later than the next day).

Base shall be mixed as required to produce a uniform mixture with water. Base shall be placed in uniform lifts not to exceed 10 inch loose lifts or 8 inch compacted lifts. Moisture and density requirements shall be as indicated on the drawings, typical minimum 98% Modified Proctor

(ASTM D1557) under flexible pavements or typical minimum 98% Standard Proctor (ASTM D698) under concrete pavement and to within $\pm 2\%$ of optimum moisture. The section may be accepted if no more than 1 of the 5 most recent moisture or density tests is outside of the specified limits, and the failed test is within $\pm 1\%$ deviation from specified moisture or density requirements.

The surface of the compacted base, after meeting moisture and density requirements, shall be primed in accordance with City Standard Specification Section 025412 "Prime Coat".

On completion of compaction and priming, the surface shall be smooth and conform to lines, grades, and sections shown on the drawings. Areas with any deviation in excess of 1/4 inch in cross-section and in lengths of 16 feet measured longitudinally shall be corrected by loosening, adding or removing material, reshaping, and recompacting by repriming and rolling.

Moisture and density shall be maintained until the paving is complete. Excessive loss of moisture shall be prevented by sprinkling, sealing, or covering with a subsequent layer. Should the base, due to any reason or cause, lose the required stability, density, or moisture before it is protected by placement of the next layer, it shall be re-compacted, refinished, and retested at the expense of the Contractor until acceptable to the City.

5. MEASUREMENT AND PAYMENT

Unless otherwise specified on the Bid Form, crushed limestone flexible base shall be measured by the square yard complete in place. Payment shall be full compensation for all materials, royalty, hauling, placing, compacting, labor, equipment, tools, and incidentals necessary for the completion of work.

Prime shall be measured and paid under separate bid item if specified on the Bid Form.

Geogrid shall be measured and paid under separate bid item if specified on the Bid Form.

SECTION 025612
CONCRETE SIDEWALKS AND DRIVEWAYS

1. DESCRIPTION

This specification shall consist of sidewalks and driveways, with or without reinforcing steel, composed of Portland cement concrete, constructed as herein specified on an approved subgrade, in conformity with the lines and grades established by the Engineer and the details shown on the drawings.

2. MATERIALS

Materials and proportions used in construction under this item shall conform to the requirements as specified for Class "A" concrete under City Standard Specification Section 030020 "Portland Cement Concrete". Reinforcing steel shall conform to the requirements as specified in City Standard Specification Section 032020 "Reinforcing Steel". Expansion joint filler shall be redwood meeting the requirements specified in City Standard Specification Section 038000 "Concrete Structures". Cap seal shall be "Greenstreak" or approved equal.

3. CONSTRUCTION METHODS

The subgrade shall be excavated, compacted and shaped to line, grade and cross-section and hand tamped and sprinkled with water. Subgrade under concrete sidewalks and driveways shall be compacted to not less than 95% Standard Proctor density. The subgrade shall be within 0-3% of optimum moisture content at the time the concrete is placed.

Forms shall be of wood or metal, of a section satisfactory to the Engineer, straight, free from warp, and of a depth equal to the thickness of the finished work. They shall be securely staked to line and grade and maintained in a true position during the depositing of concrete.

The reinforcing steel shall be placed in position as shown on the drawings. Care shall be exercised to keep all reinforcing steel in its proper location.

Driveways shall incorporate the gutter in a unified concrete placement as shown in the City Standard Detail for driveways.

Sidewalks shall be constructed in sections of the lengths shown on drawings. Unless otherwise provided by the drawings, 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 insert or board joint of the thickness shown on the drawings, placed vertically and at right angles to the longitudinal axis of the sidewalks. Where the sidewalk or driveways abut a curb or retaining wall, approved expansion joint material shall be placed along their entire length. Similar expansion joint material shall be placed around all obstructions protruding through sidewalks or driveways.

Concrete shall be mixed in a manner satisfactory to the Engineer, placed in the forms to the depth specified and spaded and tamped until thoroughly compacted and mortar entirely covers the surface. The top surface shall be floated with a wooden float to a gritty texture. The outer edges and joints shall then be rounded with approved tools to the radii shown on drawings.

5-foot wide sidewalks shall be marked into separate sections, each 5 feet in length, by the use of approved jointing tools. For other widths of sidewalk, joints to be spaced longitudinally to match the transverse width.

When completed, the sidewalks and driveways shall be cured with Type 2, white pigmented curing compound. Other methods of curing as outlined in City Standard Specification Section 038000 "Concrete Structures" will be acceptable with a required curing period of 72 hours.

4. MEASUREMENT AND PAYMENT

Unless otherwise specified on the Bid Form, concrete sidewalks and driveways shall be measured by the square foot of surface area of completed sidewalks, driveways, or sidewalks and driveways, as indicated on the drawings.

Payment shall be full compensation for preparing and compacting the subgrade; for furnishing and placing all materials including concrete, reinforcing steel and expansion joint material; and for all manipulation, labor, tools, equipment and incidentals necessary to complete the work.

SECTION 025620
PORTLAND CEMENT CONCRETE PAVEMENT

1. DESCRIPTION

This specification shall govern for the construction of Portland cement concrete pavement on a prepared subgrade or base course, in accordance with the typical sections shown on the drawings.

The concrete shall be composed of Portland cement, aggregates (fine and coarse), admixtures if desired or required, and water, proportioned and mixed as hereinafter provided.

All subsurface utilities must be inspected, tested, and accepted prior to any paving.

2. MATERIALS

(1) Cement

The cement shall be either Type I, Type II or Type III Portland cement conforming to ASTM Designation: C150, modified as follows:

Unless otherwise specified by the Engineer, the specific surface area of Type I and II cements shall not exceed 2000 square centimeters per gram (Wagner Turbidimeter – TxDOT Test Method Tex-310-D). The Contractor shall furnish the Engineer with a statement as to the specific surface area of the cement, expressed in square centimeters per gram, for each shipment.

For concrete pavements, strength requirements shall be demonstrated using flexural (beam) or compressive (cylinder) tests as required in the drawings.

Either Type I or II cement shall be used unless Type II is specified on the plans. Except when Type II is specified on the plans, Type III cement may be used when the anticipated air temperature for the succeeding 12 hours will not exceed 60°F. Type III cement shall be used when high early strength concrete pavement is specified on the drawings.

Different types of cement may be used in the same project, but all cement used in any one monolithic placement of concrete pavement shall be of the same type and brand. Only one brand of each type of cement will be permitted in any one project unless otherwise authorized by the Engineer.

Cement may be delivered in bulk where adequate bin storage is provided. All other cement shall be delivered in bags marked plainly with the name of the manufacturer and the type of cement. Similar information shall be provided in the bills of lading accompanying each shipment of packaged or bulk cement. Bags shall contain 94 pounds net. All bags shall be in good condition at time of delivery.

All cement shall be properly protected against dampness. No caked cement will be accepted.

Cement remaining in storage for a prolonged period of time may be retested and rejected if it fails to conform to any of the requirements of these specifications.

(2) Mixing Water

Water for use in concrete and for curing shall be in accordance with City Standard Specification Section 030020 "Portland Cement Concrete".

(3) Coarse Aggregate

Coarse aggregate for use in concrete mixture shall be in accordance with City Standard Specification Section 030020 "Portland Cement Concrete", Grade No. 2.

(4) Fine Aggregate

Fine aggregate for use in concrete mixture shall be in accordance with City Standard Specification Section 030020 "Portland Cement Concrete", Grade No. 1.

(5) Mineral Filler

Mineral filler shall consist of stone dust, clean crushed sand, or other approved inert material.

(6) Mortar (Grout)

Mortar for repair of concrete pavements shall consist of 1 part cement, 2 parts finely graded sand, and enough water to make the mixture plastic. When required to prevent color difference, white cement shall be added to produce the color required. When required by the Engineer, latex adhesive shall be added to the mortar.

(7) Admixtures

Calcium chloride will not be permitted. Unless otherwise noted, air-entraining, retarding and water-reducing admixtures may be used in all concrete and shall conform to the requirements of City Standard Specification Section 030020 "Portland Cement Concrete".

(8) Reinforcing Steel

Unless otherwise designated on the plans, all steel reinforcement shall be deformed bars, and shall conform to ASTM Designation: A615, Grade 60, and shall be open hearth, basic oxygen or electric furnace new billet steel in accordance with City Standard Specification Section 032020 "Reinforcing Steel".

Dowels shall be plain billet steel smooth bars conforming to ASTM Designation: A615, Grade 60, and shall have hot-dip galvanized finish.

3. STORAGE OF MATERIALS

All cement and aggregate shall be stored and handled in accordance with City Standard Specification Section 030020 "Portland Cement Concrete".

4. MEASUREMENT OF MATERIALS

Measurement of the materials, except water, used in batches of concrete, shall be in accordance with City Standard Specification Section 030020 "Portland Cement Concrete".

5. CLASSIFICATION AND MIX DESIGN

It shall be the responsibility of the Contractor to furnish the mix design to comply with the requirements herein and in accordance with THD Bulletin C-11. The Contractor shall perform, at his own expense, the work required to substantiate the design, except the testing of strength specimens, which will be done by the Engineer. Complete concrete design data shall be submitted to the Engineer for approval.

It shall also be the responsibility of the Contractor to determine and measure the batch quantity of each ingredient, including all water, so that the mix conforms to these specifications and any other requirements shown on the plans.

In lieu of the above mix design responsibility, the Contractor may accept a design furnished by the Engineer; however, this will not relieve the Contractor of providing concrete meeting the requirements of these specifications.

Trial batches will be made and tested using all of the proposed ingredients prior to placing the concrete, and when the aggregate and/or brand of cement or admixture is changed. Trial batches shall be made in the mixer to be used on the job. When transit mix concrete is to be used, the trial designs will be made in a transit mixer representative of the mixers to be used. Batch size shall not be less than 50 percent of the rated mixing capacity of the truck.

Mix designs from previous or concurrent jobs may be used without trial batches if it is shown that no substantial change in any of the proposed ingredients has been made.

This specification section incorporates the requirements of City Standard Specification Section 030020 "Portland Cement Concrete".

6. CONSISTENCY

In cases where the consistency requirements cannot be satisfied without exceeding the maximum allowable amount of water, the Contractor may use, or the Engineer may require, an approved water-reducing or retarding agent, or the Contractor shall furnish additional aggregates or aggregates with different characteristics, which will produce the required results. Additional cement may be required or permitted as a temporary measure until aggregates are changed and designs checked with the different aggregates or admixture.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When field conditions are such that additional moisture is needed for the final concrete surface finishing operation, the required water shall be applied to the surface by fog spray only, and shall be held to a minimum. The concrete shall be

workable, cohesive, possess satisfactory finishing qualities, and of the stiffest consistency that can be placed and vibrated into a homogenous mass. Excessive bleeding shall be avoided. Slump requirements shall be as specified in Table 1.

TABLE 1
Slump Requirements

<u>Construction Method</u>	<u>Desired Slump</u>	<u>Minimum Slump</u>	<u>Maximum Slump</u>
Concrete Pavement (slipformed)	1.5 inches	1 inch	3 inches
Concrete Pavement (formed)	4 inches	2.5 inches	6.5 inches

NOTE: No concrete will be permitted with slump in excess of the maximum shown.

7. QUALITY OF CONCRETE

The concrete shall be uniform and workable. The cement content, maximum allowable water-cement ratio, desired slump, minimum slump, maximum slump, and the strength requirements of the class of concrete for concrete pavement shall conform to the requirements of Table 1 and Table 2 and as required herein.

During the process of the work, the Engineer will cast test beams or cylinders as a check on the flexural or compressive strength of the concrete actually placed. Testing shall be in accordance with City Standard Specification Section 030020 "Portland Cement Concrete". If the required flexural or compressive strength is not secured with the cement specified in Table 2, changes in the batch design will be made. The concrete shall meet either the minimum flexural (beam) strength (7-day or 28-day) or minimum compressive strength (7-day or 28-day) shown in Table 2.

TABLE 2
Class of Concrete for Concrete Pavement

<u>Class of Concrete</u>	<u>Minimum Flexural (Beam) Strength</u>	<u>Minimum Compressive Strength</u>	<u>Maximum Water-Cement Ratio</u>	<u>Coarse Aggregate</u>
P*	450 psi (7 days) 570 psi (28 days)	3200 psi (7 days) 4000 psi (28 days)	5.6 gal./sack 0.50	No. 2 (1½")

* 5% entrained air

8. MIXING CONDITIONS

The concrete shall be mixed in quantities required for immediate use. Any concrete which is not in place within the limits outlined in City Standard Specification Section 038000 "Concrete Structures", Article "Placing Concrete-General", shall not be used. Re-tamping of concrete will not be permitted.

Mixing conditions shall conform to the requirements of City Standard Specification Section 030020 "Portland Cement Concrete".

9. MIXING AND MIXING EQUIPMENT

Mixing and mixing equipment shall conform to the requirements of City Standard Specification Section 030020 "Portland Cement Concrete".

10. READY-MIX PLANTS

The requirements for ready-mix plants shall be as specified in City Standard Specification Section 030020 "Portland Cement Concrete".

11. PLACING, CURING AND FINISHING

All subsurface utilities must be inspected, tested, and accepted prior to any paving.

Subgrade preparation shall be as specified on the plans. The placing of concrete, including construction of forms and falsework, curing and finishing shall be in accordance with City Standard Specification Section 038000 "Concrete Structures". For membrane curing, curing material shall conform to Type 2, Class A curing compound, or as otherwise shown on the drawings.

12. JOINTS IN CONCRETE PAVEMENT

The placing of joints in concrete pavement shall be in accordance with City Standard Specification Section 038000 "Concrete Structures" and as detailed on the drawings.

13. MEASUREMENT AND PAYMENT

Unless otherwise specified on the Bid Form, the quantities of concrete for concrete pavement(s), which will constitute the completed and accepted pavement(s) in-place, will be measured by the square yard or square foot for the indicated thickness and type of cement.

Payment shall be full compensation for furnishing, hauling, mixing, placing, curing and finishing all concrete; all grouting and pointing; furnishing and placing reinforcing steel and steel dowels as shown on the plans; furnishing and placing drains; furnishing and placing metal flashing strips; furnishing and placing expansion joint material, joint filler and sealants, and contraction (control) joints required by this specification or shown on the plans; and for all forms and falsework, labor, tools, equipment and incidentals necessary to complete the work.

Any paving placed prior to inspection, testing, and acceptance of underground utilities may be rejected by the City and will be replaced at the Contractor's expense after correcting any subsurface utility defects.

SECTION 030020
PORTLAND CEMENT CONCRETE

1. DESCRIPTION

This specification shall govern for the materials used; for the storing and handling of materials; and for the proportioning and mixing of concrete for culverts, manholes, inlets, curb and gutter, sidewalks, driveways, curb ramps, headwalls and wingwalls, riprap, and incidental concrete construction.

The concrete shall be composed of Portland cement, aggregates (fine and coarse), admixtures if desired or required, and water, proportioned and mixed as hereinafter provided.

2. MATERIALS

(1) Cement

The cement shall be either Type I, II or III Portland cement conforming to ASTM Designation: C150, modified as follows:

Unless otherwise specified by the Engineer, the specific surface area of Type I and II cements shall not exceed 2000 square centimeters per gram (Wagner Turbidimeter – TxDOT Test Method Tex-310-D). For concrete piling, the above limit on specific surface area is waived for Type II cement only. The Contractor shall furnish the Engineer, with each shipment, a statement as to the specific surface area of the cement expressed in square centimeters per gram.

For cement strength requirements, either the flexural or compressive test may be used.

Either Type I or II cement shall be used unless Type II is specified on the plans. Except when Type II is specified on the plans, Type III cement may be used when the anticipated air temperature for the succeeding 12 hours will not exceed 60°F. Type III cement may be used in all precast prestressed concrete, except in piling when Type II cement is required for substructure concrete.

Different types of cement may be used in the same structure, but all cement used in any one monolithic placement shall be of the same type and brand. Only one brand of each type will be permitted in any one structure unless otherwise authorized by the Engineer.

Cement may be delivered in bulk where adequate bin storage is provided. All other cement shall be delivered in bags marked plainly with the name of the manufacturer and the type of cement. Similar information shall be provided in the bills of lading accompanying each shipment of packaged or bulk cement. Bags shall contain 94 pounds net. All bags shall be in good condition at time of delivery.

All cement shall be properly protected against dampness. No caked cement will be accepted.

Cement remaining in storage for a prolonged period of time may be retested and rejected if it fails to conform to any of the requirements of these specifications.

(2) Mixing Water

Water for use in concrete and for curing shall be free from oils, acids, organic matter or other deleterious substances and shall not contain more than 1000 parts per million of chlorides as CL nor more than 1000 parts per million of sulfates as SO₄.

Water from municipal supplies approved by the State Health Department will not require testing, but water from other sources will be sampled and tested before use in structural concrete.

Tests shall be made in accordance with the "Method of Test for Quality of Water to be Used in Concrete" (AASHTO Method T26), except where such methods are in conflict with provisions of this specification.

(3) Coarse Aggregate

Coarse aggregate shall consist of durable particles of gravel, crushed blast furnace slag, crushed stone, or combinations thereof; free from frozen material or injurious amount 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 not contain more than 0.25 percent by weight of clay lumps, nor more than 1.0 percent by weight of shale, nor more than 5 percent by weight of laminated and/or friable particles when tested in accordance with TxDOT Test Method Tex-413-A. It shall have a wear of not more than 40 percent when tested in accordance with TxDOT Test Method Tex-410-A.

Unless otherwise specified on the plans, coarse aggregate will be subjected to five cycles of the soundness test in accordance with TxDOT Test Method Tex-411-A. The loss shall not be greater than 12 percent when sodium sulfate is used, or 18 percent when magnesium sulfate is used.

Permissible sizes of aggregate shall be governed by Table 4 and Table 1, except that when exposed aggregate surfaces are required, coarse aggregate gradation will be as specified on the plans.

When tested by approved methods, the coarse aggregate, including combinations of aggregates when used, shall conform to the grading requirements shown in Table 1.

TABLE 1
Coarse Aggregate Gradation Chart

Percent Retained on Each Sieve										
Aggregate Grade No.	Nominal Size	2-½ In.	2 In.	1-½ In.	1 In.	¾ In.	½ In.	¾ In.	No. 4	No. 8
1	2 in.	0	0 to 20	15 to 50		60 to 80			95 to 100	
2 (467)*	1-½ in.		0	0 to 5		30 to 65		70 to 90	95 to 100	
4 (57)*	1 in.			0	0 to 5		40 to 75		90 to 100	95 to 100
8	¾ in.						0	0 to 5	35 to 80	90 to 100

*Numbers in parenthesis indicate conformance with ASTM C33.

The aggregate shall be washed. The Loss by Decantation (TxDOT Test Method Tex-406-A) plus the allowable weight of clay lumps, shall not exceed one percent, or the value shown on the plans, whichever is smaller.

(4) Fine Aggregate

Fine aggregate shall consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5 percent by weight of clay lumps. When subjected to the color test for organic impurities (TxDOT Test Method Tex-408-A), it shall not show a color darker than standard.

The fine aggregate shall produce a mortar having a tensile strength equal to or greater than that of Ottawa sand mortar when tested in accordance with TxDOT Test Method Tex-317-D.

Where manufactured sand is used in lieu of natural sand for slab concrete subject to direct traffic, the acid insoluble residue of the fine aggregate shall be not less than 28 percent by weight when tested in accordance with TxDOT Test Method Tex-612-J.

When tested by approved methods, the fine aggregate or combination of aggregates, including mineral filler, shall conform to the grading requirements shown in Table 2.

TABLE 2
Fine Aggregate Gradation Chart

<u>Aggregate Grade No.</u>	<u>Percent Retained on Each Sieve</u>							
	<u>3/8 In.</u>	<u>No. 4</u>	<u>No. 8</u>	<u>No. 16</u>	<u>No. 30</u>	<u>No. 50</u>	<u>No. 100</u>	<u>No. 200</u>
1	0	0 to 5	0 to 20	15 to 50	35 to 75	70 to 90	90 to 100	97 to 100

NOTE 1: Where manufactured sand is used in lieu of natural sand, the percent retained on the No. 200 sieve shall be 94 to 100.

NOTE 2: Where the sand equivalent value is greater than 85, the retainage on the No. 50 sieve may be 70 to 94 percent.

Fine aggregate will be subjected to the Sand Equivalent Test (TxDOT Test Method Tex-203-F). The sand equivalent shall not be less than 80 nor less than the value shown on the plans, whichever is greater.

For concrete Classes 'A' and 'C', the fineness modulus as defined below for fine aggregates shall be between 2.30 and 3.10.

The fineness modulus will be determined by adding the percentages by weight retained on the following sieves, and dividing by 100; Nos. 4, 8, 16, 30, 50 and 100.

(5) Mineral Filler

Mineral filler shall consist of stone dust, clean crushed sand, or other approved inert material.

(6) Mortar (Grout)

Mortar for repair of concrete shall consist of 1 part cement, 2 parts finely graded sand, and enough water to make the mixture plastic. When required to prevent color difference, white cement shall be added to produce the color required. When required by the Engineer, latex adhesive shall be added to the mortar.

(7) Admixtures

Calcium Chloride will not be permitted. Unless otherwise noted, air-entraining, retarding and water-reducing admixtures may be used in all concrete and shall conform to the following requirements:

A "water-reducing, retarding admixture" is defined as a material which, when added to a concrete mixture in the correct quantity, will reduce the quantity of mixing water required to produce concrete of a given consistency and will retard the initial set of the concrete.

A "water-reducing admixture" is defined as a material which, when added to a concrete mixture in the correct quantity, will reduce the quantity of mixing water required to produce concrete of a

given consistency.

- (a) Retarding and Water-Reducing Admixtures. The admixture shall meet the requirements for Type A and Type D admixture as specified in ASTM Designation: C494, modified as follows:
- (1) The water-reducing retarder shall retard the initial set of the concrete a minimum of 2 hours and a maximum of 4 hours, at a specified dosage rate, at a temperature of 90°F.
 - (2) The cement used in any series of tests shall be either the cement proposed for specific work or a "reference" Type I cement from one mill.
 - (3) Unless otherwise noted on the plans, the minimum relative durability factor shall be 80.

The air-entraining admixture used in the referenced and test concrete shall be neutralized Vinsol resin.

- (b) Air-Entraining Admixture. The admixture shall meet the requirements of ASTM Designation: C260, modified as follows:
- (1) The cement used in any series of tests shall be either the cement proposed for specific work or a "reference" Type I cement from one mill.
 - (2) Unless otherwise noted on the plans, the minimum relative durability factor shall be 80.

The air-entraining admixture used in the referenced concrete shall be neutralized Vinsol resin.

3. STORAGE OF CEMENT

All cement shall be stored in well-ventilated weatherproof buildings or approved bins, which will protect it from dampness or absorption of moisture. Storage facilities shall be ample, and each shipment of packaged cement shall be kept separated to provide easy access for identification and inspection.

The Engineer may permit small quantities of sacked cement to be stored in the open for a maximum of 48 hours on a raised platform and under waterproof covering.

4. STORAGE OF AGGREGATE

The method of handling and storing concrete aggregate shall prevent contamination with foreign materials. If the aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and level. The bottom layer of aggregate shall not be disturbed or used without recleaning.

When conditions require the use of two or more sizes of aggregates, they shall be separated to prevent intermixing. Where space is limited, stockpiles shall be separated by physical barriers.

Methods of handling aggregates during stockpiling and subsequent use shall be such that segregation will be minimized.

Unless otherwise authorized by the Engineer, all aggregate shall be stockpiled at least 24 hours to reduce the free moisture content.

5. MEASUREMENT OF MATERIALS

The measurement of the materials, except water, used in batches of concrete, shall be by weight. The fine aggregate, coarse aggregate and mineral filler shall be weighed separately. Where bulk cement is used, it shall be weighed separately, but batch weighing of sacked cement will not be required. Where sacked cement is used, the quantities of material per batch shall be based upon using full bags of cement. Batches involving the use of fractional bags will not be permitted.

Allowance shall be made for the water content in the aggregates.

Bags of cement varying more than 3 percent from the specified weight of 94 pounds may be rejected, and when the average weight per bag in any shipment, as determined by weighing 50 bags taken at random, is less than the net weight specified, the entire shipment may be rejected. If the shipment is accepted, the Engineer will adjust the concrete mix to a net weight per bag fixed by an average of all individual weights which are less than the average weight determined from the total number weighed.

6. CLASSIFICATION AND MIX DESIGN

It shall be the responsibility of the Contractor to furnish the mix design, using a coarse aggregate factor acceptable to the Engineer, for the class(es) of concrete specified. The mix shall be designed by a qualified concrete technician to conform with the requirements contained herein and in accordance with the THD Bulletin C-11. The Contractor shall perform, at his own expense, the work required to substantiate the design, except the testing of strength specimens, which will be done by the Engineer. Complete concrete design data shall be submitted to the Engineer for approval.

It shall also be the responsibility of the Contractor to determine and measure the batch quantity of each ingredient, including all water, so that the mix conforms to these specifications and any other requirements shown on the plans.

Trial batches will be made and tested using all of the proposed ingredients prior to placing the concrete, and when the aggregate and/or brand of cement or admixture is changed. Trial batches shall be made in the mixer to be used on the job. When transit mix concrete is to be used, the trial designs will be made in a transit mixer representative of the mixers to be used. Batch size shall not be less than 50 percent of the rated mixing capacity of the truck.

Mix designs from previous or concurrent jobs may be used without trial batches if it is shown that

no substantial change in any of the proposed ingredients has been made.

The coarse aggregate factor shall not be more than 0.82, except that when the voids in the coarse aggregate exceed 48 percent of the total dry loose volume, the coarse aggregate factor shall not exceed 0.85. The coarse aggregate factor shall not be less than 0.70 for Grades 1, 2 and 3 aggregates.

If the strength required for the class of concrete being produced is not secured with the cement specified in Table 4, the Contractor may use an approved water-reducing or retarding admixture, or he shall furnish aggregates with different characteristics which will produce the required results. Additional cement may be required or permitted as a temporary measure until the redesign is checked.

Water-reducing or retarding agents may be used with all classes of concrete at the option of the Contractor.

When water-reducing or retarding agents are used at the option of the Contractor, reduced dosage of the admixture will be permitted.

Entrained air will be required in accordance with Table 4. The concrete shall be designed to entrain 5 percent air when Grade 2 coarse aggregate is used and 6 percent when Grade 3 coarse aggregate is used. Concrete as placed in the structure shall contain the proper amount as required above with a tolerance of plus or minus 1.5 percentage points. Occasional variations beyond this tolerance will not be cause for rejection. When the quantity of entrained air is found to be above 7 percent with Grade 2 coarse aggregate or above 8 percent for Grade 3 coarse aggregate, additional test beams or cylinders will be made. If these beams or cylinders pass the minimum flexural or compressive requirements, the concrete will not be rejected because of the variation in air content.

7. CONSISTENCY

In cases where the consistency requirements cannot be satisfied without exceeding the maximum allowable amount of water, the Contractor may use, or the Engineer may require, an approved water-reducing or retarding agent, or the Contractor shall furnish additional aggregates or aggregates with different characteristics, which will produce the required results. Additional cement may be required or permitted as a temporary measure until aggregates are changed and designs checked with the different aggregates or admixture.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When field conditions are such that additional moisture is needed for the final concrete surface finishing operation, the required water shall be applied to the surface by fog spray only, and shall be held to a minimum. The concrete shall be workable, cohesive, possess satisfactory finishing qualities, and of the stiffest consistency that can be placed and vibrated into a homogenous mass. Excessive bleeding shall be avoided. Slump requirements will be as specified in Table 3.

TABLE 3
Slump Requirements

<u>Concrete Designation</u>	<u>Desired Slump</u>	<u>Max. Slump</u>
Structural Concrete:		
(1) Thin-Walled Sections (9" or less)	4 inches	5 inches
(2) Slabs, Caps, Columns, Piers, Wall Sections over 9", etc.	3 inches	4 inches
Underwater or Seal Concrete	5 inches	6 inches
Riprap, Curb, Gutter and Other Miscellaneous Concrete	2.5 inches	4 inches

NOTE: No concrete will be permitted with slump in excess of the maximums shown.

8. QUALITY OF CONCRETE

General

The concrete shall be uniform and workable. The cement content, maximum allowable water-cement ratio, the desired and maximum slump and the strength requirements of the various classes of concrete shall conform to the requirements of Table 3 and Table 4 and as required herein.

During the process of the work, the Engineer or his designated representative will cast test cylinders or beams as a check on the compressive or flexural strength of the concrete actually placed. Test cylinders must be picked up by the testing lab within 24 hours.

A test shall be defined as the average of the breaking strength of two cylinders or two beams, as the case may be. Specimens will be tested in accordance with TxDOT Test Methods Tex-418-A or Tex-420-A.

Test beams or cylinders will be required as specified in the contract documents. For small placements on structures such as manholes, inlets, culverts, wingwalls, etc., the Engineer may vary the number of tests to a minimum of one for each 25 cubic yards placed over a several day period.

All test specimens, beams or cylinders, representing tests for removal of forms and/or falsework shall be cured using the same methods, and under the same conditions as the concrete represented.

"Design Strength" beams and cylinders shall be cured in accordance with THD Bulletin C-11.

The Contractor shall provide and maintain curing facilities as described in THD Bulletin C-11 for the purpose of curing test specimens. Provision shall be made to maintain the water in the curing tank at temperatures between 70°F and 90°F.

When control of concrete quality is by twenty-eight-day compressive tests, job control will be by seven-day compressive tests which are shown to provide the required twenty-eight-day strength, based on results from trial batches. If the required seven-day strength is not secured with the

cement specified in Table 4, changes in the batch design will be made.

TABLE 4
Classes of Concrete

Class of Concrete	Sacks Cement per C.Y. (min.)	Minimum Compressive Strength (f _c) 28-Day(psi)	Min. Beam Strength 7-Day (psi)	Maximum Water-Cement Ratio (gal/sack)	Coarse Aggregate No.
A*	5.0	3000	500***	6.5	2-4-8****
B*	4.5	2500	417	8.0	2-4-8****
C*	6.0	3600	600***	6.0	1-2-4**
D	6.0	3000	500	7.0	2-4
S	6.5	4000	570	5.0	2-4

*Entrained Air (slabs, piers and bent concrete).

**Grade 1 Coarse Aggregate may be used in foundation only (except cased drilled shafts).

***When Type II Cement is used with Class C Concrete, the 7-day beam break requirement will be 550 psi; with Class A Concrete, the minimum 7-day beam break requirement will be 460 psi.

****Permission to use Grade 8 Aggregate must have prior approval of the Engineer.

9. MIXING CONDITIONS

The concrete shall be mixed in quantities required for immediate use. Any concrete which is not in place within the limits outlined in City Standard Specification Section 038000 "Concrete Structures", Article "Placing Concrete-General", shall not be used. Retamping of concrete will not be permitted.

In threatening weather, which may result in conditions that will adversely affect the quality of the concrete to be placed, the Engineer may order postponement of the work. Where work has been started and changes in weather conditions require protective measures, the Contractor shall furnish adequate shelter to protect the concrete against damage from rainfall, or from freezing temperatures. If necessary to continue operations during rainfall, the Contractor shall also provide protective coverings for the material stockpiles. Aggregate stockpiles need be covered only to the extent necessary to control the moisture conditions in the aggregates to adequately control the consistency of the concrete.

10. MIXING AND MIXING EQUIPMENT

All equipment, tools, and machinery used for hauling materials and performing any part of the work shall be maintained in such condition to insure completion of the work underway without excessive delays for repairs or replacements.

The mixing shall be done in a batch mixer of approved type and size that will produce uniform

distribution of the material throughout the mass. Mixers may be either the revolving drum type or the revolving blade type, and shall be capable of producing concrete meeting the requirements of these specifications.

After all the ingredients are assembled in the drum, the mixing shall continue not less than 1 minute for mixers of one cubic yard or less capacity plus 15 seconds for each additional cubic yard or portion thereof.

The mixer shall operate at the speed and capacity designated by the Mixer Manufacturers Bureau of the Associated General Contractors of America. The mixer shall have a plate affixed showing the manufacturer's recommended operating data.

The absolute volume of the concrete batch shall not exceed the rated capacity of the mixer.

The entire contents of the drum shall be discharged before any materials are placed therein for the succeeding batch.

The first batch of concrete materials placed in the mixer for each placement shall contain an extra quantity of sand, cement and water sufficient to coat the inside surface of the drum.

Upon the cessation of mixing for any considerable length of time, the mixer shall be thoroughly cleaned.

The concrete mixer shall be equipped with an automatic timing device which is put into operation when the skip is raised to its full height and dumping. This device shall lock the discharging mechanism and prevent emptying of the mixer until all the materials have been mixed together for the minimum time required, and it shall ring a bell after the specified time of mixing has elapsed.

The water tank shall be arranged so that the amount of water can be measured accurately, and when the tank starts to discharge, the inlet supply shall cut off automatically.

Whenever a concrete mixer is not adequate or suitable for the work, it shall be removed from the site upon a written order from the Engineer and a suitable mixer provided by the Contractor.

Pick-up and thro-over blades in the drum of the mixer which are worn down more than 10 percent in depth shall be repaired or replaced with new blades.

Improperly mixed concrete shall not be placed in the structure.

Job mix concrete shall be concrete mixed in an approved batch mixer in accordance with the requirements stated above, adjacent to the structure for which the concrete is being mixed, and moved to the placement site in non-agitating equipment.

11. READY-MIX PLANTS

A. General. It shall be the Contractor's responsibility to furnish concrete meeting all requirement of the governing specification sections, and concrete not meeting the slump, workability and consistency requirements of the governing specification sections shall not

be placed in the structure or pavement.

Ready-Mixed Concrete shall be mixed and delivered by means of one of the following approved methods.

- (1) Mixed completely in a stationary mixer and transported to the point of delivery in a truck agitator or a truck mixer operating at truck agitator or truck mixer agitation speed. (Central-Mix Concrete)
- (2) Mixed complete in a truck mixer and transported to the placement site at mixing and/or agitating speed (Transit-Mix Concrete), subject to the following provisions:
 - (a) Truck mixers will be permitted to transport concrete to the job site at mixing speed if equipped with double actuated counters which will separate revolutions at mixing speed from total revolutions.
 - (b) Truck mixers equipped with a single actuated counter counting total revolutions of the drum shall mix the concrete at the plant not less than 50 nor more than 70 revolutions at mixing speed, transport it to the job site at agitating speed and complete the required mixing before placing the concrete.
- (3) Mixed completely in a stationery mixer and transported to the job site in approved non-agitating trucks with special bodies. This method of transporting will be permitted for concrete pavement only.

B. Equipment.

- (1) Batching Plant. The batching plant shall be provided with adequate bins for batching all aggregates and materials required by the specifications.

Bulk cement shall be weighed on a scale separate from those used for other materials and in a hopper entirely free and independent of that used for weighing the aggregates.

- (2) Mixers and Agitators.

- (a) General: Mixers shall be of an approved stationary or truck-type capable of combining the ingredients into a thoroughly mixed and uniform mass.

Facilities shall be provided to permit ready access to the inside of the drum for inspection, cleaning and repair of blades.

Mixers and agitators shall be subject to daily examination for changes in condition due to accumulation of hardened concrete and/or wear of blades, and any hardened concrete shall be removed before the mixer will be permitted to be used. Worn blades shall be repaired or replaced with new in

accordance with the manufacturer's design and arrangement for that particular unit when any part or section is worn as much as 10 percent below the original height of the manufacturer's design.

- (b) Stationary Mixers: These shall conform to the requirements of Article "Mixing and Mixing Equipment". Truck mixers mounted on a stationary base will not be considered as a stationary mixer.
- (c) Truck Mixers: In addition, truck mixers shall comply with the following requirements:

An engine in satisfactory working condition and capable of accurately gauging the desired speed of rotation shall be mounted as an integral part of the mixing unit for the purpose of rotating the drum. Truck mixers equipped with a transmission that will govern the speed of the drum within the specified revolutions per minute (rpm) will not require a separate engine.

All truck mixers shall be equipped with actuated counters by which the proper number of revolutions of the drum, as specified in Article 11. A. above, may be readily verified. The counters shall be read and recorded at the start of mixing at mixing speeds.

Each until shall have adequate water supply and accurate metering or gauging devices for measuring the amount used.

- (d) Agitators: Concrete agitators shall be of the truck type, capable of maintaining a thoroughly mixed and uniform concrete mass and discharging it within the same degree of uniformity specified for mixers. Agitators shall comply with all of the requirements for truck mixers, except for the actual mixing requirements.

C. Operation of Plant and Equipment.

Delivery of ready-mixed concrete shall equal or exceed the rate approved by the Engineer for continuous placement. In all cases, the delivery of concrete to the placement site shall assure compliance with the time limits in the applicable specification for depositing successive batches in any monolithic unit. The Contractor shall satisfy the Engineer that adequate standby trucks are available.

A standard ticket system will be used for recording concrete batching, mixing and delivery date.

Tickets will be delivered to the job inspector.

Loads arriving without ticket and/or in unsatisfactory condition shall not be used.

When a stationary mixer is used for the entire mixing operation, the mixing time for one cubic yard of concrete shall be one minute plus 15 seconds for each additional cubic yard or portion thereof. This mixing time shall start when all cement, aggregates and initial water have entered the drum.

The mixer shall be charged so that some of the mixing water will enter the drum in advance of the cement and aggregate. All of the mixing water shall be in the drum by the end of the first one-fourth of the specified mixing time. Water used to flush down the blades after charging shall be accurately measured and included in the quantity of mixing water. The introduction of the initial mixing water, except blade wash down water and that permitted in this Article, shall be prior to or simultaneous with the charging of the aggregates and cement.

The loading of truck mixers shall not exceed 63 percent of the total volume of the drum. When used as an agitator only, the loading shall not exceed 80 percent of the drum volume.

When Ready-Mix Concrete is used, additional mortar (one sack cement, three parts sand and sufficient water) shall be added to the batch to coat the drum of the mixer or agitator truck, and this shall be required for every load of Class C concrete only and for the first batch from central mix plants.

A portion of the mixing water, required by the batch design to produce the desired slump, may be withheld and added at the job site, but only with permission of the Engineer and under his supervision. When water is added under the above conditions, it shall be thoroughly mixed as specified below for water added at the job site.

Mixing speed shall be attained as soon as all ingredients are in the mixer, and each complete batch (containing all the required ingredients) shall be mixed not less than 70 nor more than 100 revolutions of the drum at mixing speed except that when water is added at the job site, 25 revolutions (minimum) at mixing speed will be required to uniformly disperse the additional water throughout the mix. Mixing speed shall be as designated by the manufacturer.

All revolutions after the prescribed mixing time shall be at agitating speed. The agitating speed shall be not less than one (1) nor more than five (5) rpm. The drum shall be kept in continuous motion from the time mixing is started until the discharge is completed.

12. PLACING, CURING AND FINISHING

The placing of concrete, including construction of forms and falsework, curing and finishing, shall be in accordance with City Standard Specification Section 038000 "Concrete Structures".

13. MEASUREMENT AND PAYMENT

Unless otherwise specified on the Bid Form, the quantities of concrete of the various classifications which will constitute the completed and accepted structure(s) in-place will be measured by the cubic yard, per each, square foot, square yard or linear foot, as the case may be. Measurement will be as shown on the drawings and/or in the Bid Form.

Payment shall be full compensation for furnishing, hauling, mixing, placing, curing and finishing all concrete; all grouting and pointing; furnishing and placing drains; furnishing and placing metal flashing strips; furnishing and placing expansion joint material required by this specification or shown on the plans; and for all forms and falsework, labor, tools, equipment and incidentals necessary to complete the work.

SECTION 032020
REINFORCING STEEL

1. DESCRIPTION

This specification shall govern the furnishing and placing of reinforcing steel, deformed and smooth, of the size and quantity designated on the plans and in accordance with these specifications.

2. MATERIALS

Unless otherwise designated on the plans, all bar reinforcement shall be deformed, and shall conform to ASTM Designation: A 615, Grades 60 or 75, and shall be open hearth, basic oxygen, or electric furnace new billet steel.

Large diameter new billet steel (Nos. 14 and 18), Grade 75, will be permitted for straight bars only.

Where bending of bar sizes No. 14 or No. 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.

Spiral reinforcement shall be smooth (not deformed) bars or wire of the minimum diameter shown on the plans, and shall be made by one or more of the following processes: open hearth, basic oxygen, or electric furnace. Bars shall be rolled from billets reduced from ingots and shall comply with ASTM Designation: A 306, Grade 65 minimum (references to ASTM Designation: A 29 is voided). Dimensional tolerances shall be in accordance with ASTM Designation: A 615, or ASTM Designation: A 615, Grade 60, except for deformations. Wire shall be cold-drawn from rods that have been hot-rolled from billets and shall comply with ASTM Designation: A 185.

In cases where the provisions of this specification are in conflict with the provisions of the ASTM Designation to which reference is made, the provisions of this specification shall govern.

Report of chemical analysis showing the percentages of carbon, manganese, phosphorus and sulphur will be required for all reinforcing steel when it is to be welded.

The nominal size and area and the theoretical weight of reinforcing steel bars covered by this specification are as follows:

<u>Bar Size Number</u>	<u>Nominal Diameter, In.</u>	<u>Nominal Area, Sq. In.</u>	<u>Weight per Linear Foot, Pounds</u>
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	7.6
18	2.257	4.00	13.60

Smooth round bars shall be designated by size number through No. 4. Smooth bars larger than No. 4 shall be designated by diameter in inches.

When wire is ordered by gauge numbers, the following relation between gauge number and diameter, in inches, shall apply unless otherwise specified:

<u>Gauge Number</u>	<u>Equivalent Diameter, Inches</u>	<u>Gauge Number</u>	<u>Equivalent Diameter, Inches</u>
0	0.3065	8	0.1620
1	0.2830	9	0.1483
2	0.2625	10	0.1350
3	0.2437	11	0.1205
4	0.2253	12	0.1055
5	0.2070	13	0.0915
6	0.1920	14	0.0800
7	0.1770		

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, the inside diameter of bar bends, in terms of the nominal bar diameter (d), shall be as follows:

Bends of 90 degrees and greater in stirrups, ties and other secondary bars that enclose another bar in the bend:

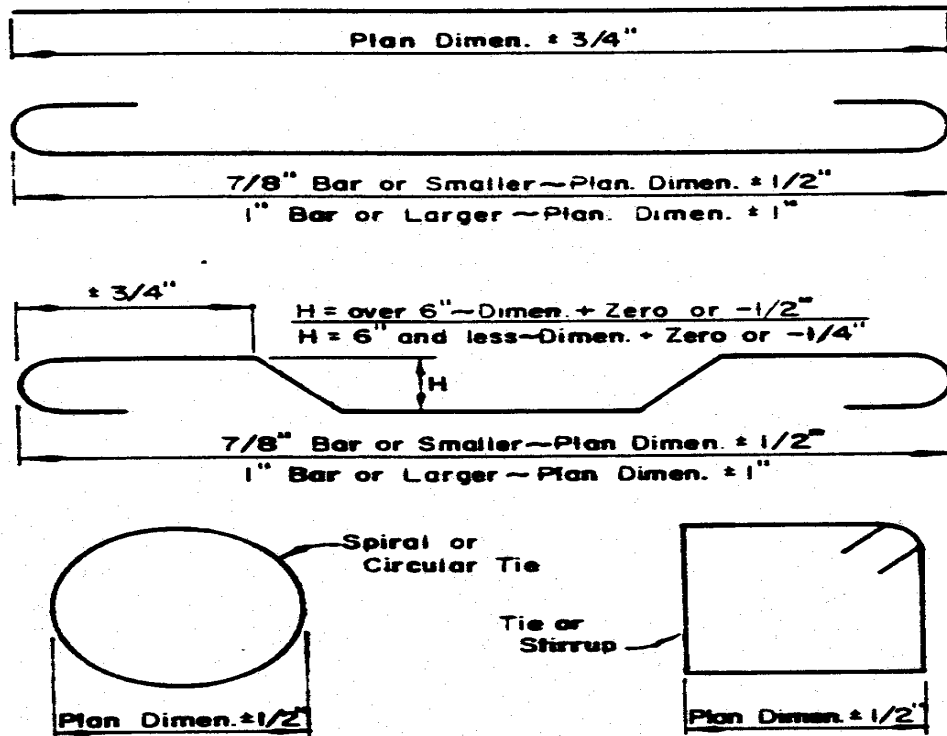
	<u>Grade 60</u>
#3, #4, #5	4d
#6, #7, #8	5d

All bends in main bars and in secondary bars not covered above:

	<u>Grade 60</u>	<u>Grade 75</u>
#3 thru #8	6d	--
#9, #10	8d	--
#11	8d	8d
#14, #18	10d	--

4. TOLERANCES

Fabricating tolerances for bars shall be within 3 percent of specified or as follows:



5. STORING

Steel reinforcement shall be stored above the surface of the ground upon platforms, skids or other supports, and shall be protected as far as practicable 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 properties of a hand wire crushed specimen meets the physical requirements for size and grade of steel specified.

6. SPLICES

No splicing of bars, except when provided on the plans or specified herein, will be permitted without written approval of the Engineer.

Splices will not be permitted in main reinforcement at points of maximum stress. When permitted in main bars, splices in adjacent bars shall be staggered a minimum of two splice lengths.

TABLE 1
Minimum Lap Requirements

<u>Lap</u>		<u>Uncoated</u>	<u>Coated</u>
Lap in inches	≥	40d	60d

Where: d = bar diameter in inches

Welding of reinforcing bars may be used only where shown on the plans or as permitted herein. All welding operations, processes, equipment, materials, workmanship and inspection shall conform to the requirements of the drawings and industry standards. All splices shall be of such dimension and character as to develop the full strength of bar being spliced.

End preparation for butt welding reinforcing bars shall be done in the field. Delivered bars shall be of sufficient length to permit this practice.

For box culvert extensions with less than one foot of fill, the existing longitudinal bars shall have a 20-diameter lap with the new bars. For box culvert extensions with more than one foot of fill, a minimum of 6 inches lap will be required.

Unless otherwise shown on the plans, dowel bars transferring tensile stresses shall have a minimum embedment equal to the minimum lap requirements shown in Table 1. Shear transfer dowels shall have a minimum embedment of 12 inches.

7. PLACING

Reinforcement shall be placed as near as possible in the position shown on the plans. Unless otherwise shown on the plans, dimensions shown for reinforcement are to the centers of the bars. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than one-twelfth of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than one-quarter inch. Cover of concrete to the nearest surface of steel shall meet the above requirements but shall never be less than one inch or as otherwise shown on the plans.

Vertical stirrups shall always pass around the main tension members and be attached securely thereto. The reinforcing steel shall be spaced its required distance from the form surface by means of approved galvanized metal spacers, metal spacers with plastic coated tips, stainless steel spacers, plastic spacers, or approved pre-cast mortar or concrete blocks. For approval of plastic spacers on the project, representative samples of the plastic shall show no visible indications of deterioration after immersion in a 5 percent solution of sodium hydroxide for 120 hours.

All reinforcing steel shall be tied at all intersections, except that where spacing is less than one foot in each direction, alternate intersections only need be tied.

Before any concrete is placed, all mortar shall be cleaned from the reinforcement. Precast mortar or concrete blocks to be used for holding steel in position adjacent to formed surfaces shall be cast in molds meeting the approval of the Engineer and shall be cured by covering with wet burlap or

cotton mats for a period of 72 hours.

The blocks shall be cast in the form of a frustum of a cone or pyramid with the smaller face placed against the forms.

A suitable tie wire shall be provided in each block, to be used for anchoring to the steel. Except in unusual cases, and when specifically otherwise authorized by the Engineer, the size of the surface to be placed adjacent to the forms shall not exceed two and one-half inches square or the equivalent thereof in cases where circular or rectangular areas are provided. Blocks shall be cast accurately to the thickness required, and the surface to be placed adjacent to the forms shall be a true plane free of surface imperfections.

Reinforcement shall be supported and tied in such manner that a sufficiently rigid case of steel is provided. If the cage is not adequately supported to resist settlement or floating upward of the steel, overturning of truss bars or movement in any direction during concrete placement, permission to continue concrete placement will be withheld until corrective measures are taken. Sufficient measurements shall be made during concrete placement to insure compliance with the first paragraph of Article 7 of this specification.

Mats of wire fabric shall overlap each other sufficiently to maintain a uniform strength and shall be fastened securely at the ends and edges.

No concrete shall be deposited until the Engineer has inspected the placement of the reinforcing steel and given permission to proceed.

8. MEASUREMENT AND PAYMENT

Unless otherwise specified on the Bid Form, reinforcing steel is considered subsidiary to the various items shown in the Bid Form and shall not be measured and paid for as a separate item.

SECTION 038000
CONCRETE STRUCTURES

1. DESCRIPTION

This specification shall govern for construction of all types of structures involving the use of structural concrete, except where the requirements are waived or revised by other governing specifications.

All concrete structures shall be constructed in accordance with the design requirements and details shown on the plans; in conformity with the pertinent provisions of the items contracted for; the incidental specifications referred to; and in conformity with the requirements herein.

2. MATERIALS

(1) Concrete. All concrete shall conform to the provisions of City Standard Specification Section 030020 "Portland Cement Concrete".

The class of concrete for each type of structure or unit shall be as specified on the plans or by pertinent governing specifications.

(2) Expansion Joint Material.

(a) Preformed Fiber Material. Preformed fiber expansion joint material shall be of the dimensions shown on the plans. The material shall be one of the following types, unless otherwise noted on the plans:

1. Preformed Bituminous Fiber Materials shall meet the requirements of ASTM Designation: D1751 "Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)".
2. Preformed Non-Bituminous Fiber Material shall meet the requirements of ASTM Designation: D1751 "Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)", except that the requirements pertaining to bitumen content, density and water absorption shall be voided.

3. Redwood.

(b) Joint Sealing Materials. Unless otherwise shown on the drawings, joint sealing material shall conform to the following requirements. The material shall adhere to the sides of the concrete joint or crack and shall form an effective seal against infiltration of water and incompressibles. The material shall not crack or break when exposed to low temperatures.

1. Class 1-a. (Two-Component, Synthetic Polymer, Cold-Extruded Type). Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles. This type is specifically designed for vertical or sloping joints and hence not self-leveling. It shall cure sufficiently at an average temperature of 77 degrees F \pm 3 degrees F in a maximum of 24 hours. For performance requirements see under 2.(2)(b)2. below.
2. Class 1-b. (Two-Component, Synthetic Polymer, Cold-Pourable, Self-Leveling Type). Curing is to be by polymerization and not by evaporation of solvent or fluxing of harder particles. It shall cure sufficiently at an average temperature of 77 degrees F \pm 3 degrees F in a maximum of 3 hours.

Performance Requirements: Class 1-a and Class 1-b joint materials, when tested in accordance with TxDOT Test Method Tex-525-C, shall meet the above curing times and the following requirements:

It shall be of such consistency that it can be mixed and poured, or mixed and extruded into joints at temperatures above 60 degrees F.

Penetration, 77° F.:	
150 gm. cone, 5 sec., max., cm.....	0.90
Bond and Extension 75%, O° F, 5 cycles:	
Dry Concrete Blocks.....	Pass
Wet Concrete Blocks.....	Pass
Steel Blocks...(Primed if specified by manuf.).	Pass
Flow at 200° F.....	None
Water Content % by weight, max.....	5.0
Resilience:	
Original sample min. % (cured).....	50
Oven aged at 158° F min. %	50
For Class 1-a Material Only:	
Cold Flow (10 min.).....	None

(c) Asphalt Board. Asphalt Board shall consist of two liners of 0.016-inch asphalt impregnated paper, filled with a mastic mixture of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat and sufficiently rigid to permit installation. When tested in accordance with TxDOT Test Method Tex-524-C, the asphalt board shall not deflect from the horizontal more than one inch in three and one-half inches (1" in 3½").

(d) Rebonded Neoprene Filler. Rebonded neoprene filler shall consist of ground closed-cell neoprene particles, rebonded and molded into sheets of uniform thickness, of the dimensions shown on plans.

Filler material shall have the following physical properties and shall meet the requirements of ASTM Designation: D1752 "Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction", Type 1, where applicable:

<u>PROPERTY</u>	<u>METHOD</u>	<u>REQUIREMENT</u>
Color	ASTM D1752, Type 1	Black
Density	ASTM D1752, Type 1	40 lb./ft ³ Min.
Recovery	ASTM D1752, Type 1	90% Min.
Compression	ASTM D1752, Type 1	50 to 500 psi
Extrusion	ASTM D1752, Type 1	0.25 inch Max.
Tensile Strength	ASTM D1752, Type 1	20 psi Min.
Elongation		75% Min.

The manufacturers shall furnish the Engineer with certified test results as to compliance with the above requirements and a 12 inch x 12 inch x 1 inch sample from the shipment for approval.

(3) Curing Materials.

(a) Membrane curing materials shall comply with ASTM Designation: C 309 "Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete", Type 1 clear or translucent, or Type 2 white-pigmented. The material shall have a minimum flash-point of 80 degrees F when tested by the "Pensky-Martin Closed Cup Method".

It 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 40 degrees F.

It shall be of such nature that it will not produce permanent discoloration of concrete surfaces nor react deleteriously with the concrete or its components. Type 1 compound shall contain a fugitive dye that will be distinctly visible not less than 4 hours nor more than 7 days after application. 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 surface at the rate of coverage specified herein, be dry to the touch in not more than 4 hours, and shall adhere in a tenacious film without running off or appreciable sagging. It shall not disintegrate, check, peel or crack during the required curing period.

The compound shall not peel or pick up 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 water retention test shall be in accordance with TxDOT Test Method Tex-219-F. Percentage loss shall be defined as the water lost after the application of the curing material was applied. The permissible percentage moisture loss (at the rate of coverage specified herein) shall not exceed the

following:

24 hours after application.....2 percent
72 hours after application.....4 percent

Type 1 (Resin Base Only) curing compound will be permitted for slab concrete in bridge decks and top slabs of direct traffic culverts.

(b) Mat curing of concrete is allowed where permitted by Table 1 in this specification or where otherwise approved by the Engineer.

3. EXPANSION JOINTS

Joints and devices to provide for expansion and contraction shall be constructed where and as indicated herein or on the plans.

All open joints and joints to be filled with expansion joint material, shall be constructed using forms adaptable to loosening or early removal. To avoid expansion or contraction damage to the adjacent concrete, these forms shall be loosened as soon as possible after final concrete set to permit free movement without requiring full form removal.

Prior to placing the sealing material, the vertical facing the joint shall be cleaned of all laitance by sandblasting or by mechanical routing. Cracked or spalled edges shall be repaired. The joint shall be blown clean of all foreign material and sealed. Where preformed fiber joint material is used, it shall be anchored to the concrete on one side of the joint by light wire or nails, to prevent the material from falling out. The top one inch (1”) of the joint shall be filled with joint sealing material.

Finished joints shall conform to the indicated outline with the concrete sections completely separated by the specified opening or joint material.

Soon after form removal and again where necessary after surface finishing, all projecting concrete shall be removed along exposed edges to secure full effectiveness of the expansion joints.

4. 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. The term “monolithic placement” shall be interpreted to mean at the manner and sequence of concrete placing shall not create construction joints.

Construction joints shall be of the type and at the locations shown on the plans. Additional joints will not be permitted without written authorization from the Engineer, and when authorized, 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 when horizontal.

Construction joints requiring the use of joint sealing material shall be as detailed on the plans. The

material will be specified on the plans without referenced to joint type.

A concrete placement terminating at a horizontal construction joint shall have the top surface roughened thoroughly as soon as practicable after initial set is attained. The surfaces at bulkheads shall be roughened as soon as the forms are removed.

The hardened concrete surface shall be thoroughly cleaned of all loose material, laitance, dirt or foreign material, and saturated with water so it is moist when placing fresh concrete against it. Forms shall be drawn tight against the placing of the fresh concrete.

5. FORMS

(1) General. Except where otherwise specified, forms may be of either timber or metal.

Forms for round columns exposed to view shall be of steel, except that other materials will be allowed with written permission of the Engineer.

Forming plans shall be submitted to the Engineer for approval as specified. 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. For job fabricated forms, an additional live load of 50 pounds per square foot shall be allowed on horizontal surfaces. The maximum unit stresses shall not exceed 125 percent of the allowable stresses used by the Texas Department of Transportation for the design of structures.

Commercially produced structural units used in formwork shall not exceed the manufacturer's maximum allowable working load for moment, shear or end reaction. The maximum working load shall include a live load of 35 pounds per square foot of horizontal form surface, and sufficient details and data shall be submitted for use in checking formwork details for approval.

Forms shall be practically mortar-tight, rigidly braced and strong enough to prevent bulging between supports, and maintained to the proper line and grade during concrete placement. Forms shall be maintained in a manner that will prevent warping and shrinkage.

Offset at form joints shall not exceed one-sixteenth of an inch (1/16").

Deflections due to cast-in-place slab concrete and railing shown in the dead load deflection diagram shall be taken into account in the setting of slab forms.

All forms and footing areas shall be cleaned of any extraneous matter before placing concrete.

Permission to place concrete will not be given until all such work is completed to the satisfaction of the Engineer.

If, at any stage of the work, the forms show signs of bulging or sagging, the portion of the concrete causing such condition shall be removed immediately, if necessary, and the forms shall be reset and securely braced against further movement.

(2) Timber Forms. Lumber for forms shall be properly seasoned, of good quality, and free from 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.

Form lining will be required for all formed surfaces, except for the inside of culvert barrels, inlets and manholes; surfaces that are subsequently covered by backfill material or are completely enclosed; and, any surface formed by a single finished board. Lining will not be required when plywood forms are used.

Form lining shall be of an approved type such as Masonite or plywood. Thin membrane sheeting, such as polyethylene sheets, shall not be used for form lining.

Forms may be constructed of plywood not less than one-half inch in thickness, with no form lining required. The grain of the face plies on plywood forms shall be placed parallel to the span between the supporting studs or joists.

Plywood used for forming surfaces that remain exposed shall be equal to that specified as B-B Plyform Class I or Class II Exterior, of the U. S. Department of Commerce, National Bureau of Standards and Technology, latest edition.

Forms or form lumber to be reused shall be maintained clean and in good condition. Any lumber which is split, warped, bulged, marred, or has defects that will produce inferior work, shall not be used and, if condemned, shall be promptly removed from the work.

Studs and joists shall be spaced so that the facing form material remains in true alignment under the imposed loads.

Wales shall be spaced close enough to hold forms securely to the designated lines and scabbed at least 4 feet on each side of joints to provide continuity. A row of wales shall be placed near the bottom of each placement.

Facing material shall be placed with parallel and square joints and securely fastened to supporting studs.

Forms for surfaces receiving only an ordinary finish and exposed to view shall be placed with the form panels symmetrical, i.e., long dimensions set in the same direction. Horizontal joints shall be continuous.

Molding specified for chamfer strips or other uses shall be made of materials of a grade that will not split when nailed and which can be maintained to a true line without warping. Wood 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 measuring three-quarter inch (3/4") on the sides.

Forms for railing and ornamental work shall be constructed to standards equivalent to first-class millwork. All moldings, panel work and bevel strips shall be straight and true with nearly mitered joints designed so the finished work is true, sharp and clean cut.

All forms shall be constructed to permit their removal without marring or damaging the concrete. The forms may be given a slight draft to permit ease of removal.

Metal form ties of an approved type or a satisfactory substitute shall be used to hold forms in place and shall be of a type that permits ease of removal of the metal as hereinafter specified.

All metal appliances used inside of forms for alignment purposes shall be removed to a depth of at least one-half inch (1/2") from the concrete surface. They shall be made so the metal may be removed without undue chipping or spalling, and when removed, shall leave a smooth opening in the concrete surface. Burning off of rods, bolts or ties will not be permitted.

Any wire ties used shall be cut back at least one-half inch (1/2") from the face of the concrete.

Devices holding metal ties in place shall be capable of developing the strength of the tie and adjustable to allow for proper alignment.

Metal and wooden spreaders which are separate from the forms shall be removed entirely as the concrete is being placed.

Adequate clean-out openings shall be provided for narrow walls and other locations where access to the bottom of the forms is not readily attainable.

Prior to placing concrete, the facing of all forms shall be treated with oil or other bond breaking coating of such composition that it will not discolor or otherwise injuriously affect the concrete surface. Care shall be exercised to prevent coating of the reinforcing steel.

(3) Metal Forms. The foregoing requirements for timber forms regarding design, mortar-tightness, filleted corners, beveled projections, bracing, alignment, removal, reuse and wetting shall also apply to metal forms, except that these will not require lining, unless specifically noted on the plans.

The thickness of form metal shall be as required to maintain the true shape without warping or bulging. 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. Metal shall be kept free from rust, grease or other foreign materials.

6. PLACING REINFORCEMENT

Reinforcement in concrete structures shall be placed carefully and accurately and rigidly supported as provided in the City Standard Specification Section 032020 "Reinforcing Steel". Reinforcing steel supports shall not be welded to I-beams or girders.

7. PLACING CONCRETE-GENERAL

The minimum temperature of all concrete at the time of placement shall be not less than 50 degrees F.

The consistency of the concrete as placed should allow the completion of all finishing operations without the addition of water to the surface. When conditions are such that additional moisture is needed for finishing, the required water shall be applied to the surface by fog spray only, and shall be held to a minimum amount. Fog spray for this purpose may be applied with hand operated fogging equipment.

The maximum time interval between the addition of cement to the batch and the placing of concrete in the forms shall not exceed the following:

<u>Air or Concrete Temperature</u>	<u>Maximum Time</u>
<u>Non-Agitated Concrete:</u>	
Above 80 degrees F	15 minutes
Up to 80 degrees F	30 minutes
<u>Agitated Concrete:</u>	
Above 90 degrees F	45 minutes
75 degrees F to 90 degrees F	60 minutes
35 degrees F to 74 degrees F	90 minutes

The use of an approved retarding agent in the concrete will permit the extension of each of the above temperature-time maximums by 30 minutes for direct traffic culverts, and one hour for all other concrete except that the maximum time shall not exceed 30 minutes for non-agitated concrete.

Before starting work, the Contractor shall inform the Engineer fully of the construction methods he proposes to use, the adequacy of which shall be subject to the approval of the Engineer.

The Contractor shall give the Engineer sufficient advance notice before placing concrete in any unit of the structure to permit the inspection of forms, reinforcing steel placement, and other preparations. Concrete shall not be placed in any unit prior to the completion of formwork and placement of reinforcement therein.

Concrete mixing, placing and finishing shall be done during daylight hours, unless adequate provisions are made to light the entire site of all operations.

Concrete placement will not be permitted when impending weather conditions will impair the quality of the finished work. If 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 Article "Placing Concrete in Cold Weather" of this specification shall be applied.

The placing of concrete shall be regulated so the pressures caused by the plastic concrete shall not exceed the loads used in form design.

The method of handling, placing and consolidation of concrete shall minimize segregation and displacement of the reinforcement, and produce a uniformly dense and compact mass. Concrete shall not have a free fall of more than 5 feet, except in the case of thin walls such as in culverts. Any hardened concrete spatter ahead of the plastic concrete shall be removed.

The method and equipment used to transport concrete to the forms shall be capable of maintaining the rate of placement approved by the Engineer. Concrete may be transported by buckets, chutes, buggies, belt conveyors, pumps or other acceptable methods.

When belt conveyors or pumps are used, sampling for testing will be done at the discharge end. Concrete transported by conveyors shall be protected from sun and wind, if necessary, to prevent loss of slump and workability. Pipes through which concrete is pumped shall be shaded and/or wrapped with wet burlap, if necessary, to prevent loss of slump and workability. Concrete shall not be transported through aluminum pipes, tubes or other aluminum equipment.

Chutes, troughs, conveyors or pipes shall be arranged and used so that the concrete ingredients will not be separated. When steep slopes are necessary, the chutes shall be equipped with baffle boards or made in short lengths that reverse the direction of movement, or the chute ends shall terminate in vertical downspouts. Open troughs and chutes shall extend, if necessary, down inside the forms or through holes left in them. All transporting equipment shall be kept clean and free from hardened concrete coatings. Water used for cleaning shall be discharged clear of the concrete.

Each part of the forms shall be filled by depositing concrete 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 and running or working it along the forms will not be allowed.

Concrete shall be deposited in the forms in layers of suitable depth but not more than 36 inches in thickness, unless otherwise directed by the Engineer.

The sequence of successive layers or adjacent portions of concrete shall be such that they can be vibrated into a homogenous mass with the previously placed concrete without a cold joint. Not more than one hour shall elapse between adjacent or successive placements of concrete. Unauthorized construction joints shall be avoided by placing all concrete between the authorized joints in one continuous operation.

An approved retarding agent shall be used to control stress cracks and/or unauthorized cold joints in mass placements where differential settlement and/or setting time may induce stress cracking.

Openings in forms shall be provided, if needed, for the removal of laitance of foreign matter of any kind.

All forms shall be wetted thoroughly before the concrete is placed therein.

All concrete shall be well consolidated and the mortar flushed to the form surfaces by continuous working with immersion type vibrators. Vibrators which operate by attachment to forms or reinforcement will not be permitted, except on steel forms. At least one stand-by vibrator shall be

provided for emergency use in addition to those required for placement.

The concrete shall be vibrated immediately after deposit. Prior to the beginning of work, a systematic spacing of the points of vibration shall be established to insure complete consolidation and thorough working of the concrete around the reinforcement, embedded fixtures, and into the corners and angles of the forms. Immersion type vibrators shall be inserted vertically, at points 18 to 30 inches apart, and slowly withdrawn. The vibrator may be inserted in a sloping or horizontal position in shallow slabs. The entire depth of each lift shall be vibrated, allowing the vibrator to penetrate several inches into the preceding lift. Concrete along construction joints shall be thoroughly consolidated by operating the vibrator along and close to but not against the joint surface. The vibration shall continue until thorough consolidation, and complete embedment of reinforcement and fixtures is produced, but not long enough to cause segregation. Vibration may be supplemented by hand spading or rodding, if necessary, to insure the flushing of mortar to the surface of all forms.

Slab concrete shall be mixed in a plant located off the structure. Carting or wheeling concrete batches over completed slabs will not be permitted until they have aged at least four (4) full curing days. If carts are used, timber planking will be required for the remainder of the curing period. Carts shall be equipped with pneumatic tires. Curing operations shall not be interrupted for the purpose of wheeling concrete over finished slabs.

After concrete has attained its initial set, at least one (1) curing day shall elapse before placing strain on projecting reinforcement to prevent damage to the concrete.

The storing of reinforcing or structural steel on completed roadway slabs generally shall be avoided and, when permitted, shall be limited to quantities and distribution that will not induce excessive stresses.

8. PLACING CONCRETE IN COLD WEATHER

(1) Cast-in-Place Concrete. Concrete may be placed when the atmospheric temperature is not less than 35 degrees F. Concrete shall not be placed in contact with any material coated with frost or having a temperature less than 32 degrees F.

Aggregates shall be free from ice, frost and frozen lumps. When required, in order to produce the minimum specified concrete temperature, the aggregate and/or the water shall be heated uniformly, in accordance with the following:

The water temperature shall not exceed 180 degrees F, and/or the aggregate temperature shall not exceed 150 degrees F. The heating apparatus shall heat the mass of aggregate uniformly. The temperature of the mixture of aggregates and water shall be between 50 degrees F and 85 degrees F before introduction of the cement.

All concrete shall be effectively protected as follows:

(a) The temperature of slab concrete of all unformed surfaces shall be maintained at 50 degrees F or above for a period of 72 hours from time of placement and above 40 degrees F for an additional 72 hours.

(b) The temperature at the surface of all concrete in piers, culverts walls, retaining walls, parapets, wingwalls, bottoms of slabs, and other similar formed concrete shall be maintained at 40 degrees F or above for a period of 72 hours from time of placement.

(c) The temperature of all concrete, including the bottom slabs of culverts placed on or in the ground, shall be maintained above 32 degrees F for a period of 72 hours from time of placement.

Protection shall consist of providing additional covering, insulated forms or other means, and if necessary, supplementing such covering with artificial heating. Curing as specified under Article "Curing Concrete" of this specification shall be provided during this period until all requirements for curing have been satisfied.

When impending weather conditions indicate the possibility of the need for such temperature protection, all necessary heating and covering material shall be on hand ready for use before permission is granted to begin placement.

Sufficient extra test specimens will be made and cured with the placement to ascertain the condition of the concrete as placed, prior to form removal and acceptance.

(2) Precast Concrete. A fabricating plant for precast products which has adequate protection from cold weather in the form of permanent or portable framework and covering, which protects the concrete when placed in the forms, and is equipped with approved steam curing facilities, may place concrete under any low temperature conditions provided:

(a) The framework and covering are placed and heat is provided for the concrete and the forms within one hour after the concrete is placed. This shall not be construed to be one hour after the last concrete is placed, but that no concrete shall remain unprotected longer than one hour.

(b) Steam heat shall keep the air surrounding the concrete between 50 degrees F and 85 degrees F for a minimum of three hours prior to beginning the temperature rise which is required for steam curing.

(c) For fabricating plants without the above facilities and for job site precast products, the requirements of the Article "Curing Concrete" of this specification shall apply.

The Contractor is responsible for the protection of concrete placed under any and all weather conditions. Permission given by the Engineer for placing concrete during freezing weather will in no way relieve the Contractor of the responsibility for producing concrete equal in quality to that placed under normal conditions. Should concrete placed under such conditions prove unsatisfactory, it shall be removed and replaced at no additional cost.

9. PLACING CONCRETE IN WATER

Concrete shall be deposited in water only when specified on the plans or with written permission by the Engineer. The forms or cofferdams 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 during the concrete placing, nor until it has set for at least 36 hours.

The concrete shall be placed with a tremie, closed bottom-dump bucket, or other approved method, and shall not be permitted to fall freely through the water nor shall it be disturbed after it has been placed. The concrete surface shall be kept approximately level during placement.

The tremie shall consist of a water-tight tube 14 inches or less in diameter. It shall be constructed so that the bottom can be sealed and opened after it is in place and fully charged with concrete. It shall be supported so that it can be easily moved horizontally to cover all the work area and vertically to control the concrete flow.

Bottom-dump buckets used for underwater placing shall have a capacity of not less than one-half cubic yard. It shall be lowered gradually and carefully until it rests upon the concrete already placed and raised very slowly during the upward travel; the intent being to maintain still water at the point of discharge and to avoid agitating the mixture.

The placing operations shall be continuous until the work is complete.

10. PLACING CONCRETE IN BOX CULVERTS

In general, construction joints will be permitted only where shown on the plans.

Where the top slab and walls are placed monolithically in culverts more than 4 feet in clear height, an interval of not less than one (1) nor more than two (2) hours shall elapse before placing the top slab to allow for shrinkage in the wall concrete.

The base slab shall be finished accurately at the proper time to provide a smooth uniform surface. Top slabs which carry direct traffic shall be finished as specified for roadway slabs in Article "Finish of Roadway Slabs". Top slabs of fill type culverts shall be given a reasonably smooth float finish.

11. PLACING CONCRETE IN FOUNDATIONS AND SUBSTRUCTURE

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.

Placing of concrete footings upon seal concrete courses will be permitted after the caissons or cofferdams are free from water and the seal concrete course cleaned. Any necessary pumping or bailing during the concreting operation shall be done from a suitable sump located outside the forms.

All temporary wales or braces inside cofferdams or caissons shall be constructed or adjusted as the work proceeds to prevent unauthorized construction joints in footings or shafts.

When footings can be placed in a dry excavation 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; in which case, measurement for payment will be based on the footing dimensions shown on the plans.

12. TREATMENT AND FINISHING OF HORIZONTAL SURFACES EXCEPT ROADWAY SLABS

All unformed upper surfaces shall be struck off to grade and finished. The use of mortar topping for surfaces under this classification will not be permitted.

After the concrete has been struck off, the surface shall be floated with a suitable float. Sidewalks shall be given a wood float or broom finish, or may be striped with a brush, as specified by the Engineer. Other surfaces shall be wood float finished and striped with a fine brush leaving a fine-grained texture.

13. FINISH OF ROADWAY SLABS

As soon as the concrete has been placed and vibrated in a section of sufficient width to permit working, the surface shall be approximately leveled, struck off and screeded, carrying a slight excess of concrete ahead of the screed to insure filling of all low spots. The screed shall be designed rigid enough to hold true to shape and shall have sufficient adjustments to provide for the required camber. A vibrating screed may be used if heavy enough to prevent undue distortion. The screeds shall be provided with a metal edge.

Longitudinal screeds shall be moved across the concrete with a saw-like motion while their ends rest on headers or templates set true to the roadway grade or on the adjacent finished slab.

The surface of the concrete shall be screeded a sufficient number of times and at such intervals to produce a uniform surface, true to grade and free of voids.

If necessary, the screeded surface shall be worked to smooth finish with a long handled wood or metal float of the proper size, or hand floated from bridges over the slab.

When required by the Engineer, the Contractor shall perform sufficient checks with a long handled 10-foot straightedge on the plastic concrete to insure that the final surface will be within the tolerances specified below. The check shall be made with the straightedge parallel to the centerline. Each pass thereof shall lap half of the preceding pass. All high spots shall be removed and all depressions over one-sixteenth inch (1/16") in depth shall be filled with fresh concrete and floated. The checking and floating shall be continued until the surface is true to grade and free of depressions, high spots, voids or rough spots.

Rail support holes shall be filled with concrete and finished to match the top of the slab.

Surface Texturing.

Perform surface texturing using a either carpet drag or metal tining as indicated on the drawings. Complete final texturing before the concrete has attained its initial set. Draw the carpet drag

longitudinally along the pavement surface with the carpet contact surface area adjusted to provide a satisfactory coarsely textured surface. A metal-tine texture finish is required using a tining machine unless otherwise shown on the plans. Provide the metal-tine finish immediately after the concrete surface has set enough for consistent tining. Operate the metal-tine device to obtain grooves spaced at 1 in., approximately 3/16 in. deep, with a minimum depth of 1/8 in., and approximately 1/12 in. wide. Do not overlap a previously tined area. Use manual methods for achieving similar results on ramps and other irregular sections of pavements. Repair damage to the edge of the slab and joints immediately after texturing. Do not tine pavement that will be overlaid.

Upon completion of the floating and/or straight edging and before the disappearance of the moisture sheen, the surface shall be given a broom or burlap drag finish. The grooves of these finishes shall be parallel to the structure centerline. It is the intent that the average texture depth resulting from the number of tests directed by the Engineer be not less than 0.035 inch with a minimum texture depth of 0.030 inch for any one test when tested in accordance with TxDOT Test Method Tex-436-A. Should the texture depth fall below that intended, the finishing procedures shall be revised to produce the desired texture.

After the concrete has attained its final set, the roadway surface shall be tested with a standard 10-foot straightedge. The straightedge shall be placed parallel to the centerline of roadway to bridge any depressions and touch high spots. Ordinates of irregularities measured from the face of the straightedge to the surface of the slab shall not exceed one-eighth of an inch (1/8"), making proper allowances for camber, vertical curvature and surface texture. Occasional variations, not exceeding three-sixteenth of an inch (3/16") will be acceptable, if in the opinion of the Engineer it will not affect the riding qualities.

When directed by the Engineer, irregularities exceeding the above requirements shall be corrected.

In all roadway slab finishing operations, camber for specified vertical curvature and transverse slopes shall be provided.

14. CURING CONCRETE

The Contractor shall inform the Engineer fully of the methods and procedures proposed for curing; shall provide the proper equipment and material in adequate amounts; and shall have the proposed methods, equipment and material approved prior to placing concrete.

Inadequate curing and/or facilities, therefore, shall be cause for the Engineer to stop all construction on the job until remedial action is taken. All concrete shall be cured for a period of four (4) curing days except as noted herein.

EXCEPTIONS TO 4-DAY CURING

<u>Description</u>	<u>Required Curing</u>
Upper Surfaces of Bridge Slabs and Top Slabs of Direct Traffic Culverts	8 curing days (Type I or III) cement 10 curing days (Type II cement)
Concrete Piling (non-prestressed)	6 curing days

When the air temperature is expected to drop below 35 degrees F, the water curing mats shall be covered with polyethylene sheeting, burlap-polyethylene blankets or other material to provide the protection required by Article "Placing Concrete in Cold Weather" of these specifications.

A curing day is defined as a calendar day when the temperature, taken in the shade away from artificial heat, is above 50 degrees F for at least 19 hours (colder days if satisfactory provisions are made to maintain the temperature of all surfaces of the concrete above 40 degrees F for the entire 24 hours). The required curing period shall begin when all concrete therein has attained its initial set.

The following methods are permitted for curing concrete subject to the restrictions of Table 1 and the following requirements for each method of curing.

(1) Form Curing. When forms are left in contact with the concrete, other curing methods will not be required except for cold weather protection.

(2) Water Curing. All exposed surfaces of the concrete shall be kept wet continuously for the required curing time. The water used for curing shall meet the requirements for concrete mixing water as specified in the specification Section 030020 "Portland Cement Concrete". Seawater will not be permitted. Water which stains or leaves an unsightly residue shall not be used.

(a) Wet Mat. Cotton mats shall be used for this curing method. They shall be placed as soon as possible after the surface has sufficiently hardened to prevent damage to the concrete. (See Article, "Placing Concrete" of this specification.) Damp burlap blankets made from nine-ounce stock may be placed on the damp concrete surface for temporary protection prior to the application of the cotton mats which may be placed dry and wetted down after placement.

The mats shall be weighted down adequately to provide continuous contact with all concrete surfaces where possible. The surfaces of the concrete shall be kept wet for the required curing time. Surfaces which cannot be cured by contact shall be enclosed with mats and anchored positively to the forms or to the ground so that outside air cannot enter the enclosure. Sufficient moisture shall be provided inside the enclosure to keep all surfaces of the concrete wet.

(b) Water Spray. This curing method shall consist of overlapping sprays or sprinklers that keep all unformed surfaces continuously wet.

(c) Ponding. This curing method requires the covering of the surfaces with a minimum of two inches (2") of clean granular material, kept wet at all times, or a minimum of one-inch

(1”) depth of water. Satisfactory provisions shall be made to provide a dam to retain the water or saturated granular material.

(3) Membrane Curing. This consists of curing concrete pavement, concrete pavement (base), curbs, gutters, retards, sidewalks, driveways, medians, islands, concrete riprap, cement-stabilized riprap, concrete structures and other concrete as indicated on the plans by impervious membrane method.

Unless otherwise provided herein or shown on the plans, either Type 1-D or Type 2 membrane curing compound may be used where permitted except that Type 1-D (Resin Base Only) will be required for slab concrete in bridge decks and top slabs of direct traffic culverts.

TABLE 1

	<u>STRUCTURE UNIT DESCRIPTION</u>	<u>REQUIRED</u>		<u>PERMITTED</u>	
		<u>WATER FOR CURING</u>	<u>MEMBRANE FOR INTERIM CURING</u>	<u>WATER FOR CURING</u>	<u>MEMBRANE FOR INTERIM CURING</u>
1	Top slabs of direct traffic culverts	X	X		
2	Top surface of any concrete unit upon which concrete is to be placed and bonded at a later interval (Stub walls, risers, etc.). Other superstructure concrete (wing walls, parapet walls, etc.)	X			
3	Concrete pavement (base), curbs, gutters, retards, sidewalks, driveways, medians, islands, concrete structures, concrete riprap, etc.			X*	X*
4	All substructure concrete, culverts, box sewers, inlets, manholes, retaining walls			X*	X*

*Polyethylene sheeting, burlap-polyethylene mats or laminated mats to prevent outside air from entering will be considered equivalent to water or membrane curing for items 3 and 4.

Membrane curing shall not be applied to dry surfaces, but shall be applied just after free moisture has disappeared. Formed surfaces and surfaces which have been given a first rub shall be dampened and shall be moist at the time of application of the membrane.

When membrane is used for complete curing, the film shall remain unbroken for the minimum curing period specified. Membrane which is damaged shall be corrected immediately by reapplication of membrane. Unless otherwise noted herein or on the plans, the choice of membrane type shall be at the option of the Contractor. Only one type of curing compound will be permitted on any one structure.

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 a single uniform coating of curing compound applied at the rate of coverage recommended by the manufacturer and directed by the Engineer, but not less than 1 gallon per 180 square feet of area. The Contractor shall provide satisfactory means and facilities to properly control and check the rate of application of the compound.

The compound shall be thoroughly agitated during its use and shall be applied by means of approved mechanical power pressure sprayers. The sprayers used to apply the membrane to concrete pavement or concrete pavement (base) shall travel at uniform speed along the forms and be mechanically driven. The equipment shall be of such design that it will insure uniform and even application of the membrane material. The sprayers shall be equipped with satisfactory atomizing nozzles. Only on small miscellaneous items will the Contractor be permitted to use hand-powered spray equipment. 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. If the surface of the concrete has become dry, it shall be moistened prior to application of membrane by fogging or mist 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 compound for the period of time designated in the governing specification for curing, either for membrane curing or for other methods. Should the foregoing indicate that any area during the curing period is not protected, 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.

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 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 under this contract.

15. REMOVAL OF FORMS

Except as herein provided, forms for vertical surfaces may be removed when the concrete has aged not less than one day (24 hours) when Type I and Type II cement is used, and not less than one-half day (12 hours) when Type III cement is used, provided it can be done without damage to the concrete.

Forms for inside curb faces may be removed in approximately three hours provided it can be done without damage to the curb.

16. FINISHING EXPOSED SURFACES

Concrete shall be finished as required in the specification Section for the respective item or as otherwise specified on the plans.

An ordinary surface finish shall be applied to all concrete surfaces either as a final finish or preparatory to a higher finish.

Ordinary Surface Finish shall be as follows:

After form removal, all porous or honey-combed areas and spalled areas shall be corrected by chipping away all loose or broken material to sound concrete.

Feather edges shall be eliminated by cutting a face perpendicular to the surface. Shallow cavities shall be repaired using adhesive grout or epoxy grout. If judged repairable by the Engineer, large defective areas shall be corrected using concrete or other material approved by the Engineer.

Holes and spalls caused by removal of metal ties, etc., shall be cleaned and filled with adhesive grout or epoxy grout. Exposed parts of metal chairs on surfaces to be finished by rubbing, shall be chipped out to a depth of one-half inch (1/2") and the surface repaired.

All fins, runs, drips or mortar shall be removed from surfaces which remain exposed. Form marks and chamfer edges shall be smoothed by grinding and/or dry rubbing.

Grease, oil, dirt, curing compound, etc., shall be removed from surfaces requiring a higher grade of finish. Discolorations resulting from spillage or splashing of asphalt, paint or other similar material shall be removed.

Repairs shall be dense, well bonded and properly cured, and when made on surfaces which remain exposed and do not require a higher finish, shall be finished to blend with the surrounding concrete.

17. MEASUREMENT AND PAYMENT

Unless otherwise specified on the Bid Form, no direct measurement or payment will be made for the work to be done or the equipment to be furnished under this specification, but it shall be considered subsidiary to the particular items required by the plans and the contract documents.

SECTION
STRUCTURAL TABLE OF CONTENTS
SPECIFICATIONS
FOR
BEAR LANE GENERATOR
5658 BEAR LANE CORPUS CHRISTI

SECTION

STRUCTURAL SPECIFICATIONS

014500	Windstorm Construction Requirements
033000	Cast-in-Place Concrete
042300	Reinforced Unit Masonry
312333	Structural Excavation, Backfill and Compaction



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TX Firm No. F-417

7-17-2023



SECTION 01 45 00
WINDSTORM CONSTRUCTION NOTES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplemental conditions and other Division 1 specification sections, apply to this section.

1.2 SUMMARY

- A. All exterior building materials, components and cladding shall meet or exceed the wind load requirements as specified in this section and on sheet S0.
- B. Glazed exterior wall and roof opening components shall be impact resistant or provided with impact resistant removable cover meeting the requirements of this section.
- C. All exterior building materials, components and cladding shall be supplied and installed in accordance with the requirements of the International Building Code, 2018.

1.3 DEFINITIONS

- A. Components and Cladding: Elements assembled to form the exterior wall and roof systems that are either directly loaded by the wind or receive wind loads originating at relatively close locations, and that transfer loads to the main wind force resisting system. Examples: roofing, curtain walls, exterior glass windows and panels, roof sheathing, studs, etc.
- B. Exterior Wall and Roof Openings: Openings that are likely to be breached during high winds. Examples: windows, doors, louvers, etc.
- C. Impact Resistant Components and Cladding: Components and cladding designed to resist, without breaching, the force from collisions with wind driven projectiles or missiles.

1.4 DESIGN REQUIREMENTS

- A. Wind loads shall be determined from the pressures developed by a 142 mph basic wind speed (three-second gust), Exposure Category C, Risk Category II, and appropriate factors from the American Society of Civil Engineers (ASCE) 7-16 "Minimum Design Loads for Buildings and Other Structures". Wind loads shall be determined accordingly.
- B. Impact resistant components and cladding shall be evaluated in accordance with ASTM E 1996 and ASTM E-1886. Impact resistant components and cladding located within 30 feet above grade shall meet or exceed the Large Missile Test of ASTM E 1996.

1.5 SUBMITTALS

- A. All components and cladding shall have the appropriate Texas Department of Insurance product evaluation number indicated on the submittal.
 - 1. Components and cladding, including installation thereof, not contained in the product evaluation list shall be certified by the manufacturer, supplier and/or installer to meet the requirements of this section.
 - 2. Installation instructions indicating fasteners, minimum attachment requirements, and other necessary pertinent information for installation shall be submitted.

1.6 EXECUTION

- 1. The Contractor is responsible for providing windstorm inspections and certification.
- 2. The Contractor shall provide, and have available at the jobsite, all necessary installation instructions during construction.
- 3. Prior to covering or concealing the fasteners or connectors, the Contractor shall notify the architect/engineer.
- 4. Contractor shall furnish, upon completion, written confirmation that installation and materials used for all components and cladding is in conformance with the requirements of this section.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Concrete formwork.
- B. Slabs on grade.
- C. Concrete reinforcement.
- D. Joint devices associated with concrete work.
- E. Concrete curing.

1.2 REFERENCE STANDARDS

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; American Concrete Institute International; 2010.
- B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; American Concrete Institute International; 1991 (Reapproved 2009).
- C. ACI 301 - Specifications for Structural Concrete; American Concrete Institute International; 2016.
- D. ACI 302.1R - Guide for Concrete Floor and Slab Construction; American Concrete Institute International; 2015.
- E. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; American Concrete Institute International; 2000.
- F. ACI 305R - Hot Weather Concreting; American Concrete Institute International; 2020.
- G. ACI 308R - Guide to Curing Concrete; American Concrete Institute International; 2016.
- H. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2019(22).
- I. ACI 347 - Guide to Formwork for Concrete; American Concrete Institute International; 2014.
- J. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Billet-Steel Bars for Concrete Reinforcement; 2015.
- K. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2018.
- L. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2021.
- M. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2022.
- N. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2015.
- O. ASTM C150/C150M - Standard Specification for Portland Cement; 2015.
- P. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2016.
- Q. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2022.
- R. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017.

1.3 SUBMITTALS

- A. See Section 013000 – Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- C. Shop Drawings, Concrete Reinforcement: Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Except as may be modified by the Contract Drawings, comply with the ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules; stirrup spacing; diagrams of bent bars; arrangement of concrete reinforcement; and types and placement of supporting accessories. Include special

reinforcement required at openings through concrete structures. Indicate proposed construction joint locations.

- D. Mix Design: Submit proposed concrete mix design.
 - 1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
 - 2. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.
- E. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.
- F. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.4 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301 and ACI 318.
- B. Follow recommendations of ACI 305R when concreting during hot weather.

1.5 PRE-CONCRETE CONFERENCE

- A. At least 35 days prior to start of the concrete construction schedule, the Contractor shall conduct a meeting to review the proposed mix designs and to discuss the required methods and procedures to achieve the required concrete construction. Coordination of the slab finish procedure will need to be discussed at this time. The finish procedure shall take into account the size of the slab and the temperature at the time of concrete placement. The Contractor shall send a pre-concrete conference agenda to all attendees 20 days prior to the scheduled date of the conference.
- B. The Contractor shall require responsible representatives of every party who is concerned with the concrete work to attend the conference, including but not limited to the Contractor's superintendent, laboratory responsible for the concrete design mix, the laboratory responsible for field quality control, the concrete placement and finishing subcontractor, the ready-mix concrete producer, the admixture manufacturer's, and the concrete pumping contractor. The Engineer shall also be notified so that he may be present at the conference.
- C. Minutes of the meeting shall be recorded, typed and printed by the Contractor and distributed by him to all parties concerned within 5 days of the meeting. Copies of the minutes shall also be transmitted to the Owner and Engineer for information purposes.
- D. The minutes shall include a statement by the Contractor's Superintendent, Concrete Placement and Finishing Subcontractor, Ready-mix Concrete Supplier, Admixture Manufacturer(s), and the Concrete Pumping Subcontractor (if applicable) indicating that the proposed mix designs, placing, finishing, and curing techniques will meet the requirements of these specifications.

PART 2 – PRODUCTS

2.1 FORMWORK

- A. Formwork Design and Construction: Comply with guidelines of ACI 347 to provide formwork that will produce concrete complying with tolerances of ACI 117.
- B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
 - 1. Form Facing for Exposed Finish Concrete: Plywood complying with U. S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible trademark of an approved inspection agency.
 - 2. Earth Cuts: If the surrounding soil will not cave in during construction operations, grade beams may be earth formed. However, exposed surfaces of concrete shall be wood formed.
 - 3. Form Coating: Release agent that will not adversely affect concrete.

2.2 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M Grade 60 (420); except stirrups and ties may be grade 40 (280).
 - 1. Type: Deformed billet-steel bars.
 - 2. Finish: Unfinished, unless otherwise indicated.
 - B. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 18 gage.
 - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
 - 3. Provide plastic or plastic coated steel components for placement within 2 inches of weathering surfaces.
- 2.3 CONCRETE MATERIALS
- A. Cement: ASTM C150, Type I - Normal Portland type.
 - 1. Acquire all cement for entire project from same source
 - B. Fine and Coarse Aggregates: ASTM C33.
 - C. Fly Ash: ASTM C618, Class C or F.
 - D. Water: Clean and not detrimental to concrete.
- 2.4 ADMIXTURES
- A. General: Admixtures shall not contain more chloride ions than are present in municipal drinking water.
 - B. Water Reducing Admixture: The admixture shall conform to ASTM C494, Type A.
 - C. Water Reducing, Retarding Admixture: The admixture shall conform to ASTM C494, Type D.
 - D. High Range Water-Reducing (HRWR) Admixture (Superplasticizer): The admixture shall conform to ASTM C494, Type F or G.
 - E. Air Entraining Admixture: The admixture shall conform to ASTM C260.
 - F. Prohibited Admixtures: Calcium chloride, thiocyanates or admixtures containing more than 0.05% chloride ions are not permitted.
 - G. Certification: Written conformance to the above mentioned requirements and the chloride ion content of the admixture will be required from the admixture manufacturer prior to mix design review the Engineer.
- 2.5 BONDING AND JOINTING PRODUCTS
- A. Bonding and Repair Materials:
 - 1. Repair Topping: Self-leveling, polymer modified high strength or approved substitute topping. Product shall be "Thin Top SL" by The Euclid Chemical Co., or approved equal.
 - 2. Polymer patching Mortar: "Euco Thin Coat, Concrete Coat" (horizontal repairs), "Verticoat LPL" (vertical and overhead repairs) by The Euclid Chemical Co. or "Sikatop 121 or 122" (horizontal repairs), "Sikatop 123" vertical and overhead repairs) by Sika Chemical Corp., or approved equal.
- 2.6 CURING MATERIALS
- A. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound, that dissipates within 3 to 5 weeks; complying with ASTM C309.
 - 1. Provide product containing fugitive red dye.
 - a. Products: SpecChem, LLC; SpecRez, or W.R. Meadows, Inc.; 1100-Clear, or approved equal.
 - B. Polyethylene Film: ASTM D2103, 6 mil thick, clear.
 - C. Water: Potable, not detrimental to concrete.
- 2.7 CONCRETE MIX DESIGN
- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
 - 1. Replace as much Portland cement as possible with fly ash, ground granulated blast furnace slag, silica fume, or rice hull ash as is consistent with ACI recommendations.
 - B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.

1. For trial mixtures method, employ independent testing agency acceptable to Engineer for preparing and reporting proposed mix designs.
 - C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.
 - D. Normal Weight Concrete:
 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 3,000 pounds per square inch.
 2. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
 3. Water-Cement Ratio: Maximum 50 percent by weight.
 4. Total Air Content: 4% to 6%, determined in accordance with ASTM C173/C173M.
 5. Maximum Slump: 5" maximum.
 6. Maximum Aggregate Size: 1-1/2 inch.
- 2.8 MIXING
- A. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.2 PREPARATION

- A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.
- B. Verify that forms are clean and free of rust before applying release agent.
- C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

3.3 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

- A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.
- B. Provide corner bars at all grade beam intersections. Match size and spacing of intersecting steel reinforcing. Provide 40 bar diameter laps with continuous steel.
- C. Unless otherwise noted, all 90, 135, and 180 degree hooks shown on the drawings shall be standard ACI hooks.
- D. All continuous reinforcement shall lap 40 bar diameters at splices. All bars for beams and slabs shall be continuous without splices.
- E. Verify that reinforcement, and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.
- F. Provide 3" clearance for all reinforcement cast against earth. Provide 2" clearance for reinforcement cast against formwork. Provide 2" clearance for slab reinforcement, unless noted otherwise in the Drawings.
- G. Field cutting of reinforcing bars shall be by shearing or sawing. Field cutting by cutting torch is not allowed. Heating or welding reinforcing bars is prohibited.

3.4 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Notify Engineer not less than 48 hours prior to commencement of placement operations.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- E. Ensure reinforcement, inserts, and embedded parts will not be disturbed during concrete placement.
- F. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing

laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.

- G. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.5 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. Maximum Variation of Surface Flatness (All Concrete Floors): 1/8 inch in 10 ft.
- B. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:
 - 1. All Concrete Floors: F(F) of 25; F(L) of 20.
- C. Measure F(F) and F(L) in accordance with ASTM E1155, within 48 hours after slab installation; report both composite overall values and local values for each measured section.
- D. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 17/F(L) 15.
- E. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.6 CONCRETE FINISHING

- A. Repair surface defects immediately after removing formwork.
- B. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/8 inch or more in height. Provide finish as follows:
 - 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.
 - 2. Concrete Slabs: Apply a broom finish to exterior concrete slab-on-grade and equipment pad. Immediately after floating finishing, slightly roughen trafficked surface by brooming with a fiber-bristle broom perpendicular to main traffic route.

3.7 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
 - 1. Normal Concrete: Not less than 7 days.
- C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
- D. Surfaces Not in Contact with Forms:
 - 1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days.
 - a. Spraying: Spray water over floor slab areas and cover with a moisture-retaining sheet: Lap strips not less than 3 inches and seal with waterproof tape or adhesive; secure at edges. Provide and maintain adequate weights/anchors to prevent sheeting from blowing off of slab prior to the end of initial 3 day curing period.
 - 2. Final Curing: Begin after initial curing but before surface is dry.
 - a. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

3.8 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
- E. Compressive Strength Tests: ASTM C39/C39M. For each test, mold and cure four concrete test cylinders. Obtain test samples for each day each class of concrete is placed.
- F. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.

3.9 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Engineer and Contractor within 24 hours of test.
 - B. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements. This includes, but is not limited to, blemishes, honeycombs, spalls, cracks, and other imperfections.
 - C. Repair or replacement of defective concrete will be determined by the Engineer. The cost of additional testing shall be borne by Contractor when defective concrete is identified. Repairs shall be completed by the Contractor to the Owner's satisfaction at no additional cost
 - D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area. Submit concrete repair materials to Engineer for review prior to repairs.
- 3.10 PROTECTION
- A. Do not permit traffic over unprotected concrete floor surface until fully cured.
 - B. Do not load concrete until fully cured.

END OF SECTION

SECTION 04 23 00
REINFORCED UNIT MASONRY

PART 1 – GENERAL

1.1 DESCRIPTION

A. This section specifies requirements for construction of reinforcement for masonry unit walls.

1.2 RELATED WORK

A. Refer to Section 01 41 00 "Testing Laboratory Services" for Testing laboratory facilities and qualifications of its principals and key personnel to perform tests.

1.3 TESTING LABORATORY-CONTRACTOR RETAINED

- A. Engage a commercial testing laboratory approved by Owner to perform tests specified below.
- B. Submit information regarding testing laboratory's facilities and qualifications of technical personnel to Resident Engineer.

1.4 TESTS

If mortar mix in accordance with ASTM C270 and jobsite mixed by proportion, no mortar tests will be required.

- A. Test mortar and materials specified.
- B. Certified test reports.
- C. Identify materials by type, brand name and manufacturer or by origin.
- D. Do not use materials until laboratory test reports are approved by Engineer.
- E. After tests have been made and materials approved, do not change without additional test and approval of Engineer.
- F. Testing:
 - 1. Test materials proposed for use for compliance with specifications in accordance with test methods contained in referenced specifications and as follows:
 - 2. Mortar:
 - a. Test for compressive strength and water retention; ASTM C780.
 - b. Mortar compressive strengths 28 days as follows:
 - (i) Type S: Minimum 1800 psi at 28 days
- G. During progress of work, testing laboratory specified in Section TESTING LABORATORY SERVICES, takes and tests samples as specified in that section. Testing procedures and test methods in ASTM C780.

1.5 SUBMITTALS

- A. Submit in accordance with Section 01 34 00, SAMPLES AND SHOP DRAWINGS.
- B. Mill Certificates: Submit steel producer's certificates of mill analysis, tensile and bend tests for reinforcement steel required for project.
- C. Laboratory Test Reports:
 - 1. Mortar, each type
 - 2. Admixtures
- D. Shop Drawings: Submit shop drawings for fabrication, bending, and placement of reinforcing bars. Comply with ACI 315. Show bar schedules, diagrams of bent bars, stirrup spacing, lateral ties and other arrangements and assemblies as required for fabrication and placement of reinforcement for unit masonry work.
- E. Manufacturer's Literature and Data:
 - 1. Strip reinforcement
 - 2. Reinforcing bars
- F. Concrete Masonry Units: Contractor to submit samples of manufacturer's standard size to be used in matching the existing concrete masonry units.
- G. Mortar: Contractor to submit color samples of manufacturer's standard mortar colors for matching the existing mortar.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver masonry materials in original sealed containers marked with name of manufacturer and identification of contents.
 - B. Store masonry materials under waterproof covers on planking clear of ground, and protect damage from handling, dirt, stain, water and wind.
- 1.7 DESIGN REQUIREMENTS
- A. Design all elements with the latest published version of applicable codes.
- 1.8 APPLICABLE PUBLICATIONS
- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only. Refer to the latest edition of all referenced Standards and codes.
 - B. American Concrete Institute (ACI)
 - 1. ACI 315: Details and Detailing of Concrete Reinforcement
 - C. American Society for Testing and Materials (ASTM):
 - 1. A82: Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
 - 2. A615/A615M: Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 - 3. A675/A675M: Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
 - 4. C40: Organic Impurities in Fine Aggregates for Concrete
 - 5. C91: Masonry Cement
 - 6. C144: Aggregate for Masonry Mortar
 - 7. C150: Portland Cement
 - 8. C207: Hydrated Lime for Masonry Purposes
 - 9. C270: Mortar for Unit Masonry
 - 10. C404: Aggregate for Masonry Grout
 - 11. C476: Grout for Masonry
 - 12. C780: Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
 - 13. C1090: Sampling and Testing Grout
 - 14. C1329: Mortar Cement
 - D. American Welding Society (AWS):
 - 1. D1.4: Structural Welding Code – Reinforcing Steel

PART 2 – PRODUCTS

- 2.1 MATERIALS
- A. Concrete masonry units shall be as shown on the Drawings, Grade N, Type 1 - Moisture Controlled, lightweight block in conformance with ASTM C90. Provide special shapes as required. Minimum compressive strength of CMU must be 1900 psi on the net area.
 - 1. Concrete masonry unit color to be selected from manufacturer's standard colors.
- 2.2 REINFORCEMENT
- A. Steel Reinforcing Bars: ASTM A615, deformed bars, Grade 60 for bars No. 3 to No. 18, except as otherwise indicated.
 - B. Shop-fabricate reinforcement bars which are shown to be bend or hooked.
 - C. Strip Reinforcement:
 - 1. Form from wire complying with ASTM A82.
 - 2. Galvanized after fabrication.
 - 3. Width of strip reinforcement 1-5/8 inches less than nominal width of masonry wall or partition.
 - 4. Cross wires welded to longitudinal wires.
 - 5. Strip reinforcing at least 10 feet in length.
 - 6. Strip reinforcing in rolls is not acceptable.
 - 7. Strip reinforcing that is crimped to form drip is not acceptable.

- 8. Maximum spacing of cross wires 16 inches to longitudinal wires.
 - 9. Ladder Design:
 - a. Longitudinal wires deformed 0.1620 inch (4 mm) diameter wire.
 - b. Cross wires 0.1483 inch (4 mm) diameter.
- 2.3 MASONRY MORTAR
- A. Conform to ASTM C270.
 - B. Admixtures:
 - 1. Do not use mortar admixtures, unless approved by Engineer.
 - 2. Submit laboratory test report showing effect of proposed admixture on strength, water retention, and water repellency of mortar.
 - 3. Do not use antifreeze compounds.
 - C. Mortar color to be selected from manufacturer's standard colors.
- 2.4 AGGREGATE FOR MASONRY GROUT
- A. ASTM C404, Size 8

PART 3 – EXECUTION

3.1 PLACING REINFORCEMENT

- A. General: Clean reinforcement of loose rust, mill scale, earth, ice or other materials which will reduce bond to mortar or grout. Do not use reinforcement bars with kinks or bends not shown on the Contract Drawings or final shop drawings, or bars with reduced cross-section due to excessive rusting or other causes.
- B. Position reinforcement accurately at the spacing indicated. Support and secure vertical bars against displacement. Horizontal reinforcement may be placed as the masonry work progresses. Where vertical bars are shown in close proximity, provide a clear distance between bars of not less than the nominal bar diameter or 1 inch (25 mm), whichever is greater.
- C. Splice reinforcement bars where shown; do not splice at other places unless accepted by the Engineer. Provide lapped splices, unless otherwise indicated. In splicing vertical bars or attaching to dowels, lap ends, place in contact and wire tie.
- D. Provide not less than minimum lap as indicated on shop drawings, or if not indicated, as required by governing code.
- E. Embed metal ties in mortar joints as work progresses, with a minimum mortar cover of 5/8 inch (15 mm) on exterior face of walls and 1/2 inch (13 mm) at other locations.
- F. Embed prefabricated horizontal joint reinforcement as the work progresses, with a minimum cover of 5/8 inch (15 mm) on exterior face of walls and 1/2 inch (13 mm) at other locations. Lap units not less than 6 inches (150 mm) at ends. Use prefabricated "L" and "T" units to provide continuity at corners and intersections. Cut and bend units as recommended by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures and other special conditions.
- G. Anchoring: Anchor reinforced masonry work to supporting structure as indicated.
- H. Anchor reinforced masonry walls to non-reinforced masonry where they intersect.

3.2 INSTALLATION, GENERAL

- A. Temporary Formwork: Provide formwork and shores as required for temporary support of reinforced masonry elements.
- B. Construct formwork to conform to shape, line and dimensions shown. Make sufficiently tight to prevent leakage of mortar, grout, or concrete (if any). Brace, tie and support as required to maintain position and shape during construction and curing of reinforced masonry.
- C. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and all other reasonable temporary loads that may be placed on them during construction.
- D. Allow sufficient time to elapse after completion of members before removing shores or forms, provided suitable curing conditions have been obtained during the curing period.

3.3 INSTALLATION OF REINFORCED CONCRETE UNIT MASONRY

- A. Do not wet concrete masonry units (CMU).
- B. Lay CMU units with full-face shell mortar beds. Fill vertical head joints (end joints between units) solidly with mortar from face of unit to a distance behind face equal to not less than the thickness of longitudinal face shells. Solidly bed cross-webs of starting courses in mortar. Maintain head and bed joint widths shown, or if not shown, provide 3/8 inch (10 mm) joints.
- C. Where solid CMU units are shown, lay with full mortar head and bed joints.
- D. Walls:
 - 1. Pattern Bond: Lay CMU wall units in 1/2-running bond with vertical joints in each course centered on units in courses above and below, unless otherwise indicated. Bond and interlock each course at corners and intersections. Use special-shaped units where shown, and as required for corners, jambs, sash, control joints, lintels, bond beams and other special conditions.
 - 2. Maintain vertical continuity of core or cell cavities, which are to be reinforced and grouted, to provide minimum clear dimension indicated and to provide minimum clearance and grout coverage for vertical reinforcement bars. Keep cavities free of mortar. Solidly bed webs in mortar where adjacent to reinforced cores or cells.
 - 3. Where horizontal reinforced beams (bond beams) are shown, use special units or modify regular units to allow for placement of continuous horizontal reinforcement bars. Place small mesh expanded metal lath or wire screening in mortar joints under bond beam courses over cores or cells of non-reinforced vertical cells, or provide units with solid bottoms.
- E. Grouting:
 - 1. Use "Fine Grout" per ASTM C476 for filling spaces less than 4 inches (100 mm) in one or both horizontal directions.
 - 2. Use "Coarse Grout" per ASTM C476 for filling 4 inch (100 mm) spaces or larger in both horizontal directions.
 - 3. Grouting Technique: At the Contractor's option, use either low-lift or high-lift grouting techniques subject to requirements which follow.
- F. Low-Lift Grouting:
 - 1. Provide minimum clear dimension of 2 inches (50 mm) and clear area of 8 square inches (5160 mm²) in vertical cores to be grouted.
 - 2. Place vertical reinforcement prior to laying of CMU. Extend above elevation of maximum pour height as required for splicing. Support in position at vertical intervals not exceeding 192 bar diameters nor 10 feet (3 m).
 - 3. Lay CMU to maximum pour height. Do not exceed 5 foot (1.5 m) height, or if bond beam occurs below 5 foot (1.5 m) height, stop pour at course below bond beam.
 - 4. Pour grout using chute or container with spout. Rod or vibrate grout during placing. Place grout continuously; do not interrupt pouring of grout for more than one hour. Terminate grout pours 1-1/2 inches (38 mm) below top course of pour.
 - 5. Bond Beams: Stop grout in vertical cells 1-1/2 inches (38 mm) below bond beam course. Place horizontal reinforcement in bond beams; lap at corners and intersections as shown. Place grout in bond beam course before filling vertical cores above bond beam.
- G. High-Lift Grouting:
 - 1. Do not use high-lift grouting technique for grouting of CMU unless minimum cavity dimension and area is 3 inches (75 mm) and 10 square inches (6450 mm²), respectively.
 - 2. Provide cleanout holes in first course at all vertical cells which are to be filled with grout.
 - 3. Use units with one face shell removed and provide temporary supports for units above, or use header units with concrete brick supports, or cut openings in one face shell.
 - 4. Construct masonry to full height of maximum grout pour specified, prior to placing grout.

5. Limit grout lifts to a maximum height of 5 feet (1.5 m) and grout pour to a maximum height of 24 feet (7.3 m), for single wythe hollow concrete masonry walls, unless otherwise indicated.
6. Place vertical reinforcement before grouting. Place before or after laying masonry units, as required by job conditions. Tie vertical reinforcement to dowels at base of masonry where shown and thread CMU over or around reinforcement. Support vertical reinforcement at intervals not exceeding 192 bar diameters nor 10 feet (3 m).
7. Where individual bars are placed after laying masonry, place wire loops extending into cells as masonry is laid and loosed before mortar sets. After insertion of reinforcement bar, pull loops and bar to proper position and tie free ends.
8. Where reinforcement is prefabricated into cage units before placing, fabricate units with vertical reinforcement bars and lateral ties of the size and spacing indicated.
9. Place horizontal beam reinforcement as the masonry units are laid.
10. Embed lateral tie reinforcement in mortar joints where indicated. Place as masonry units are laid, at vertical spacing shown.
11. Where lateral ties are shown in contact with vertical reinforcement bars, embed additional lateral tie reinforcement in mortar joints. Place as shown, or if not shown, provide as required to prevent grout blowout or rupture of CMU face shells, but provide not less than 8 gage (4.1 mm) diameter wire ties spaced 16 inches (400 mm) O.C. for members with 20 inches (500 mm) or less side dimensions, and 8 inches (200 mm) O.C. for members with side dimensions exceeding 20 inches (500 mm).
12. Preparation of Grout Spaces: Prior to grouting, inspect and clean grout spaces. Remove dust, dirt, mortar droppings, loose pieces of masonry and other foreign materials from grout spaces. Clean reinforcement and adjust to proper position. Clean top surface of structural members supporting masonry to ensure bond. After final cleaning and inspection, close cleanout holes and brace closures to resist grout pressures.
13. Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist displacement of masonry units and breaking of mortar bond. Install shores and bracing, if required, before starting grouting operations.
14. Place grout by pumping into grout spaces unless alternate methods are acceptable to the Engineer.
15. Limit grout pours to sections which can be completed in one working day with not more than one hour interruption of pouring operation. Place grout in lifts which do not exceed 5 feet (1.5 m). Allow not less than 30 minutes, nor more than one hour between lifts of a given pour. Rod or vibrate each grout lift during pouring operation.
16. Place grout in lintels or beams over openings in one continuous pour.
17. Where bond beam occurs more than one course below top of pour, fill bond beam course to within 1 inch (25 mm) of vertically reinforced cavities, during construction of masonry.
18. When more than one pour is required to complete a given section of masonry, extend reinforcement beyond masonry as required for splicing. Pour grout to within 1-1/2 inch (38 mm) of top course of first pour. After grouted masonry is cured, lay masonry units and place reinforcement for second pour section before grouting. Repeat sequence if more pours are required.

END OF SECTION

SECTION 31 23 33
STRUCTURAL EXCAVATION, BACKFILL AND COMPACTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Excavation, backfilling, and compacting for foundations.
- B. Filling holes, pits, and excavations generated as a result of removal (demolition) operations within the footprint of the foundation.

1.2 SITE INFORMATION

- A. Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for the convenience of Contractor.
- B. Test borings and other exploratory operations may be made by Contractor at no cost to Owner.

1.3 DEFINITIONS

- A. Finish Grade Elevations: Indicated on Drawings.

1.4 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012.
- B. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Materials Sources: Submit name of imported materials source.
- C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
- D. Compaction Density Test Reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When fill materials need to be stored on site, locate stockpiles where they will not interfere with construction activities.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

1.7 EXCAVATION SAFETY

- A. All excavation and backfill operations shall be in accordance with the latest OSHA excavation safety standards OSHA 2226 and CFR Part 1926 Subpart P.

PART 2 – PRODUCTS

2.1 FILL MATERIALS

- A. Structural Fill – Select, No-Expansive Fill
 - 1. PI between 7 and 17.
 - 2. Liquid Limit less than 35.
 - 3. Free of lumps larger than 2 inches, rocks larger than 2 inches, and debris.
 - 4. Conforming to ASTM D2487; classified as a clayey-sand (SC) or sandy-clay (CL).

2.2 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

1. If select non-expansive fill material is obtained from a borrow pit, material properties shall be tested at the borrow pit at a rate of one test per 250 cubic yards to verify consistency of material and compliance with specified requirements.
- C. If tests indicate materials do not meet specified requirements, change material and retest.
- D. Provide materials of each type from same source throughout the Work.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the Work are as indicated.
- B. Identify required lines, levels, contours, and datum locations.

3.2 PREPARATION

- A. Protection of Persons, Property and the Environment.
 1. Before start of earthwork operations, adequately protect existing structures, utilities, trees, shrubs, sidewalks, pavements, other facilities and adjacent property from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
 2. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights as recommended by authorities having jurisdiction.
 3. Costs resulting from damage to permanent facilities due to negligence or lack of adequate protection will be charged to the Contractor. The Contractor will also be charged for damage to the facilities scheduled for later removal or demolition if the damage sufficiently impairs proper operation to the extent that temporary replacement or repair is required.
 4. Environmental Safeguards and Regulations: The Contractor shall comply with all local, State, and Federal regulations to prevent pollution of air and water, including but not limited to City of Corpus Christi erosion and sedimentation control guidelines.
 5. The Contractor shall conduct his operations in such fashion that trucks and other vehicles do not create a dirt nuisance in the streets. The truck beds shall be sufficiently tight, and shall be loaded in such a manner that objectionable materials will not be spilled onto the streets. Any dirt, mud, or other materials that are spilled onto the streets or deposited onto the streets by the tires of vehicles shall be promptly cleared away by the Contractor.

3.3 CLEARING

- A. Completely remove all trees, shrubs and stumps from Work area. Do not remove trees from outside these areas without the specific permission of the Engineer. Exercise care to prevent injury to the trunks, branches and roots of trees and shrubs which are to remain. Trees that remain shall be protectively boxed. Leave boxing in place until finish grading is completed. Do cutting and trimming only as directed.
- B. Remove all concrete slabs, concrete walls, foundations, etc., on the site as required to properly construction the project.

3.4 STRIPPING

- A. Before excavation is begun, strip the exposed surficial grade to an 8 inch minimum depth from areas to be occupied by the foundation, and pile in designated locations where it will not interfere with building or utility operations.

3.5 EXCAVATION

- A. General:
 1. Perform excavation of every type of material encountered within the limits of the project, to the lines, grades and elevations indicated and as specified herein. Perform excavation and filling in a manner and sequence that will provide drainage at all times. Slope embankments or provide bracing or sheeting to prevent caving and injuries to workmen or damage to work.

2. Excavation for grade beams may begin after the placement of fill material has been approved by the Engineer. The excavation for grade beams may be done with a ditching machine.
- B. Water in Excavations: Keep all excavations dry by diverting or pumping seepage or surface water from excavations.
 - C. Excavated Materials: Use "satisfactory" materials from excavations to provide the rough grading and fill around the building. Coordinate with site grading requirements. Remove and legally dispose of surplus materials from the site.
 - D. Excavate the area a minimum of 24" below existing grade. The excavated area and subsequent select non-expansive fill shall extend a minimum of 2'-0" beyond the face of the foundation. The exposed surface shall be proof-rolled with a heavy rubber tired roller weighing at least 25 tons. Any soft or weak areas shall be removed and replaced with compacted select non-expansive fill. Compact subgrade to 95% of maximum dry density as determined by ASTM D698.
- 3.6 FILLING
- A. Select Non-Expansive Fill:
 1. Place material in equal continuous layers not exceeding 8 inches in loose depth and compact, dried or moistened as required to obtain optimum moisture content (-2% to +2%).
 2. Compact each layer to 95% maximum dry density per ASTM D 698, or above optimum moisture content.
 3. Use hand operated compaction equipment and 4" loose lifts in confined areas and areas immediately adjacent to utility lines.
 - B. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.
 - C. Fill to elevations indicated.
 - D. Fill up to the bottom of slab unless otherwise indicated.
 - E. Employ a placement method that does not disturb or damage other work.
 - F. Slope grade away from foundation and existing building. Make gradual grade changes. Blend slope into level areas. Coordinate with site grading requirements.
 - G. Correct areas that are over-excavated.
- 3.7 TOLERANCES
- A. Top Surface of Select Non-Expansive Fill: Plus or minus 1 inch from required elevations.
- 3.8 FIELD QUALITY CONTROL
- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.
 - B. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D698 ("standard Proctor").
 - C. If tests indicate work does not meet specified requirements, remove work, replace and retest.
 - D. Frequency of Tests: Field density tests shall be performed on each lift of fill material at the rate of one test per 2500 square feet of material placed.
- 3.9 CLEANING
- A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

END OF SECTION

SECTION
MEP TABLE OF CONTENTS
SPECIFICATIONS
FOR
BEAR LANE GENERATOR
5658 BEAR LANE CORPUS CHRISTI

SECTION

PLUMBING SPECIFICATIONS

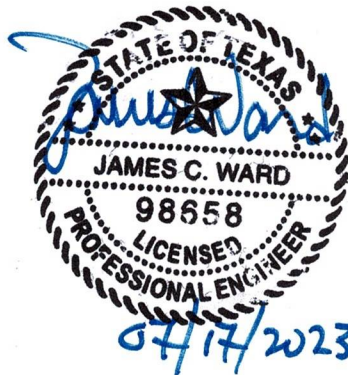
Section 22 05 00	Basic Plumbing Requirements
Section 22 10 00	Plumbing Piping

ELECTRICAL SPECIFICATIONS

Section 26 00 10	Special Provisions for Electrical Work
Section 26 01 10	Raceways
Section 26 01 11	Conduit and Fittings
Section 26 01 20	Wire and Cable 600 V and Under
Section 26 01 31	Junction and Pull Boxes
Section 26 06 12	Emergency Power Systems



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SECTION 22 05 00
BASIC PLUMBING REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The general provisions of the Contract, including General Conditions, General Requirements, and Division 1 of the Specifications, apply to all Sections of Division 22.
- B. Other Contract Documents complement the requirements and apply to the work of Division 22.

1.2 SCOPE OF WORK

- A. The work of this Section shall include the furnishing of systems, equipment and materials specified in this Division, and as called for in the Plumbing Drawings.
 - 1. All facilities, supervision, coordination, transportation, handling, labor and methods for the fabrication, installation, interconnections, painting and other finishes, start-up, tests, adjustments, clean-up and other necessary work for the complete and satisfactory systems and equipment, ready for operation and use, shall be included.
 - 2. Whenever the words "Contractor" appear in this Division, they refer to the Contractor responsible for work specified in that Section.
 - 3. The Contractor shall examine all Contract Documents including all drawings, all sections of the Specifications, plumbing and fire-protection design requirements and system design details.
 - a. The Contractor is responsible for ascertaining the extent all those documents, drawings, sections of specifications, design requirements, and system design details affect work herein specified.
 - 4. Report all errors, omissions, conflicts or code violations to Architect and Owner prior to commencement of work.
- B. Drawings for the work are diagrammatic, intended to convey the scope of the work and indicate the general arrangement and locations of the work, follow as closely as actual construction and as other work permits.
 - 1. Because of the scale of the drawings, not all basic items such as necessary duct and pipe offsets, pipefittings, access panels and sleeves may be on the plans.
 - 2. Contract documents show design basis equipment.
 - 3. Plumbing Contractor shall be responsible for installing the Owner approved equipment. Substitutions of equal quality, capacity, performance, efficiency, weight, physical size, and configuration to fit in the space provided for the design basis equipment may be allowed if pre-approved by Mechanical Engineer.
 - 4. If the Contractor selects equipment other than the design basis, he is responsible for the necessary design modifications and for coordination with other trades to meet all intended requirements of the original design documents.
 - 5. The location and the sizes of equipment, duct and pipefittings, access panels, sleeves, inserts, and other basic items required by code or other Sections shall be coordinated and included for the proper installation of the Work.
- C. The Contractor shall make any required changes from the Contract Documents to make this work conform to the building construction or the work of other trades at no additional cost to the Owner and shall not impact the project's time schedule.
 - 1. The Contractor shall indicate all changes from the Contract Documents on the shop drawings.
 - 2. Submit the shop drawings to the Architect, Engineer, and Owner for approval before commencing the work.
 - 3. Failure to follow the approval procedure may result in the forced removal of all work, performed prior to approval.
 - 4. Final "as build" documents shall include all changes.

- D. Equipment specification may not deal individually with the minor items required such as components, parts, controls, and devices that may be required to produce the equipment performance specified or as required to meet the equipment design performance and warranties.
 - 1. The equipment supplier shall include such required items whether or not specifically called for in the Contract Documents and the Contractor shall properly install them.
- E. Contractor shall verify with the supplier of the equipment the requirements for the complete installation to insure proper operation of the equipment furnished under Division 22 of the Specifications.
- F. Contract Documents may call for Plumbing Contractor to install specific equipment furnished by others, including Owner purchased equipment.
- G. Consider the specifications and drawings as complimentary one to the other.
 - 1. Where equipment items, material and labor are specified, indicated, called for or implied by either the drawings or the specifications, they shall be deemed as specified by both and included as part of the contract.
 - 2. Should conflicts occur between the drawings and the Division 22 Specifications, the more stringent requirements shall apply and take precedent.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: All work shall be in compliance with, of all applicable Laws, Codes, Standards and Regulations of Governmental Bodies having jurisdiction over work performed for or on behalf of the Owner, and over the applicable job site
 - 1. See Section 01 41 00 - Regulatory Requirements
 - a. If there should be conflicting requirements between above referenced codes than the following rules shall apply:
 - 1. The Mechanical Engineer or the Authority Having Jurisdiction (AHJ) shall provide final code interpretations and resolutions of conflicts
 - 2. The code that affords the greatest degree of life safety shall take precedent.
- B. Contractor shall request the A/E for clarification of any part of the contract documents, which may be in conflict with the above codes and regulations.
 - 1. Contractor shall prepare proposed changes for review and approval by A/E and Owner.

1.4 ACTIVE SERVICES

- A. Protect any existing active services: water, gas, sewer, and electric, against damage.
- B. Do not prevent or disturb operation of active services that are to remain.
- C. When encountering services requiring temporary interruption or relocation, request procedural information from authority having jurisdiction and coordinate work with the utility service users.
- D. Where abandoning an existing service, terminate in conformance with the Utility or Municipality having jurisdiction, and shown termination points on "as-built" construction plans.

1.5 SITE INSPECTION

- A. Contractor shall carefully inspect the site to be familiar with conditions that affect the work.
 - 1. Contractor shall verify points of connection of utilities, routing of outside piping to include required clearances from any existing structures, trees or other obstacles.
 - 2. Contractor shall verify available space in the existing structure and accessibility required for the installation of work under this contract and inform the A/E to conditions, which may be detrimental or will prevent proper execution of the work.
- B. The submittal of a bid is an acknowledgement that the Contractor performed the site inspection and has no conflicts with performing the work.
 - 1. If a conflict arises do to an observable condition the Contractor should have seen in the pre-bid site visit, the Owner is under no obligation to authorize any additional payments.
- C. Submittal of bid shall indicate that the Contractor has included all required allowances in the bid.

1. The Owner shall not make allowances for any code violations or errors resulting from Contractor's failure to visit job site and review all contract documents, applicable codes, and standards.

1.6 COMMISSIONING

- A. Commissioning of a system or systems specified in this section is part of the construction process.
- B. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Authority.
- C. Project Closeout is dependent on successful completion of all documentation, and issue closure, see Section 01 77 00 - Contract Closeout, for substantial completion details.
- D. Refer to Section 22 05 05, Plumbing Commissioning, for detailed commissioning requirements

PART 2 MATERIALS

2.1 GENERAL

- A. Each system component installed by Contractor shall meet or exceed the performance specification requirements listed in the Contract Documents including drawings, specifications, Plumbing and Fire Protection Design Requirements and Design Details.
 1. Components with a lesser degree of performance or quality as determined by the Owner, Building Department, design A/E or documented as inferior shall be replaced with no additional charge to Owner.
- B. Materials and equipment shall be new, unused, standard current products from manufacturers regularly engaged in the production of such equipment and shall bear label of the Underwriters' Laboratory for the intent use or shall be materials approved by the code-enforcing agency.
- C. Where two or more units of the same class of equipment or material are required, these shall be the product of a single manufacturer throughout entire project and shall fit in the allocated spaces provided, complying with all clearances and codes.
- D. All hardware and accessory fittings shall be a type designed, intended or appropriate for use, be compatible, and compliment the item with which they are used.
 1. They shall have corrosion protection suitable for atmosphere they are installed.
 2. All such hardware shall be U.S. standard size.
- E. All materials including insulation, jackets, and adhesives shall have a Flame Spread Rating not exceeding 25, and Smoke Developed Rating not exceeding 50, when tested in accordance with NFPA 255, "Methods of Test of Surface Burning Characteristics of Building Materials".
 1. Submittal data shall specifically indicate those ratings.
- F. All equipment and piping supports shall be hot dipped galvanized except for special corrosion protection as otherwise noted in Contract Documents.
 1. Hangers for copper pipe shall be vinyl coated.
 2. Do not use copper clad hangers.
- G. Plumbing and fire protection system components shall conform to federal, state, and local sound emission and vibration isolation guidelines.
 1. Objectionable noise or excessive vibration created in any part of the building by operation of any equipment under this contract is not permitted.
- H. Follow installations directions and recommendations of material and equipment manufacturers.

PART 3 EXECUTION

3.1 GENERAL

- A. Licensed Contractors shall perform construction work as required by AHJ.
 1. The Contractor shall not work outside the scope of his license.
 2. Any person who is not licensed must work under direct supervision of a person who has a license required by the state law and by the county or municipal licensing ordinances.

3. The Owner may request the change of the job supervisor.
 4. Workers skilled and competent in the type of work involved shall accomplish the installation.
 5. Workmanship throughout shall correspond to the standards of the best trade practices.
- B. Contractor shall install all systems and equipment in accordance with the Contract Documents, and equipment or material manufacturer recommendations and instructions.
 - C. Work lines and established grades shall be in strict accordance with the Contract Documents.
 1. The Contractor shall furnish to all trades, in ample time, any information they need to construct all equipment bases, trenches, pits, chases, and openings in floors, walls, and finishes to provide required working clearances.
 2. The contractor shall set all sleeves, anchor bolts, or inserts to fasten equipment before pouring of adjacent concrete.
 - D. Coordinate location of all Division 21 & 22 work with Division 23, 25, 26, 27 & 28.
 1. Do not run piping, and similar Division 21 & 22 work in NEC dedicated service areas for electrical equipment, including above panel boards, starters, communication panels, control panels, telephone backboards, data panels, and similar electrical elements.
 2. Do not install water piping directly above electrical equipment.
 3. In electrical rooms with required piping, provide drain pan(s) to protect the electrical equipment.
 4. Refer questionable locations to the A/E for resolution prior to installation and correct non-conforming installed work at no additional cost to the Owner.
 - E. Cap or plug all piping systems (hot water, potable water, pneumatic piping, at the end of each workday until system is complete to prevent contamination.

3.2 COORDINATION OF WORK AND DRAWINGS

- A. Each contractor and subcontractor shall be responsible for coordinating the installation of his equipment/labor with the General Contractor and work of other Contractors and trades.
 1. The contractor shall coordinate the work of different trades to prevent interference between piping, ductwork, equipment, and structural work.
- B. Recommend each contractor prepare their shop drawings at 1/4" to 1'-0" scale clearly indicating all applicable components and coordinate the same with other trades.
 1. Recommend shop coordination drawings show in detail the space conditions of all concerned trades, and be reviewed and accepted by the A/E.
 2. Contractor's failure to coordinate work between trades using coordination shop drawings or other means will not cause for any additional cost changes to the Owner, and/or changes to the project schedule.
 3. If the contractor installs his work before coordinating with other trades or causes interference with work of other trades, the contractor shall make necessary changes in the work to correct the condition, at no additional cost to the Owner, and/or changes to the project schedule.

3.3 SUBMITTALS

- A. Method or procedures for submitting shop drawings and submittal data shall comply with the General Conditions.
- B. Prior to ordering equipment and material, the Contractor shall submit 3 copies of the manufacturer's cut sheets to the Engineer for review and acceptance
 1. Submittal data shall consist of shop drawings and/or catalog cuts showing technical data necessary to evaluate the material or equipment.
 2. Including dimensions, required service and maintenance clearances, wiring diagrams, performance curves, ratings, control sequence.
 3. Layout plan showing the arrangement of the equipment with piping, and other data necessary to describe fully the item proposed and its operating characteristics.
- C. Other submittals shall include, but not be limited to:
 1. Valves
 2. Pipe insulation
 3. Controls

4. Thermometers and gauges

3.4 SUBSTITUTIONS

- A. Contractor shall follow the contract drawings and specifications, unless he submits written request for a substitution and receives written acceptance from the Engineer and OWNER.
 - 1. Owner's representative shall review the request and either approve or deny the in writing.
- B. All approval procedures regarding proposed substitutions as "approved equal" or "Engineer and Owner approved" shall meet the requirements of Section 01 60 00.

3.5 ACCESS PANELS

- A. Contractor shall provide required access panels or doors for all serviceable equipment in concealed locations whether or not called for on the drawings.

3.6 CUTTING AND PATCHING

- A. Coordinate the placing of openings in the existing or new structures as required for installation of the Plumbing Work.
- B. Any additional patching and finish work required for unnecessary openings due to failure to inspect and coordinate work, is at no additional cost to the Owner.
- C. Any additional cutting and patching of the structure necessary due to failure to install piping, ducts, sleeves or equipment on schedule, or due to failure to furnish, on schedule, the information required for leaving of openings, is at no additional cost to the Owner.
- D. Provide cutting and patching, surface finishing and painting in the existing structure, as required for the installation of work, and furnish lintels and supports as required for openings.
 - 1. Do not cut structural members without written prior approval of the A/E.
 - 2. Minimize cutting by using core drills, power saws, or other machines that will provide neat, minimum openings.
 - 3. Patching shall match adjacent materials and surfaces and be performed by artisans skilled in the respective craft.

3.7 SLEEVES

- A. Sleeves are required for all piping passing through masonry or concrete partitions (walls, floors ceilings, roofs) and through concrete beams, foundations, and footings.
 - 1. Position sleeves in formwork prior to placement of concrete.
 - 2. Provide concrete reinforcing around sleeves.
- B. Sleeves for piping passing through non-load bearing or non-fire or smoke rated walls and partitions may be required if included in the design documents by the Engineer.
 - 1. When required, sleeves shall be galvanized sheet steel with lock seam joints of minimum gauges as follows: pipes 2½" and smaller - 24 gage; 3" to 6" - 22 gage; over 6" - 20 gage.
- C. Sleeves for piping passing through load bearing walls, concrete beams, foundations, footings and waterproof floors shall be Schedule 40 galvanized steel pipe or 18 gage galvanized sheet steel.
- D. Sleeves for insulated piping shall be of sufficient internal diameter to take pipe and insulation and allow free movement of pipe due to expansion and contraction.
 - 1. Provide for continuous insulation wrapping.
 - 2. Waterproof sleeves shall be of sufficient internal diameter for pipe and waterproofing material.
- E. In finished areas where pipes are exposed, terminate sleeves flush with wall, partitions, and ceilings, and shall extend ½" above finished floor level.
 - 1. Extend sleeves 1" above finished floors in areas likely to entrap water.
 - 2. Caulk floor sleeves.
- F. Flash sleeves passing through waterproofing membrane as required by Division 7.
- G. Protect pipe penetrations through fire-rated partitions (walls, floors, or ceilings) in per with FBC.
 - 1. Protected penetration shall retain the original integrity of the fire rated partition.
 - 2. Unprotected penetrations through fire-rated partitions not allowed.

3. All materials, products, and procedures used to complete the fire stopping assemblies shall be tested, listed, and approved by testing laboratories such as U.L. or Factory Mutual and comply with requirements of ASTM-E-119.
4. Securely fasten sleeves to the partition that are part of the required approved fire stopping.
5. Close off annular spaces between sleeves, pipes, and between penetrating item and adjacent work with UL listed and approved fire stopping materials and caulk airtight.
6. Insulation and coverings shall not penetrate the fire-rated partition unless it is part of the approved U.L or Factory Mutual fire-stopping assembly.
7. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

3.8 ESCUTCHEONS

- A. Provide chrome-plated escutcheons at each sleeve opening into finished spaces.
- B. Escutcheons shall fit around insulation or around pipe when not insulated; outside diameter shall cover sleeve.
- C. Where sleeve extends above finished floor, escutcheon shall be high cap type and shall clear sleeve extension.
- D. Secure escutcheons or plates to sleeve but not to insulation with setscrews or other approved devices.

3.9 PROTECTION

- A. Take special care for the protection of equipment and materials furnished.
 1. Store and completely protect all materials from damage.
 2. Keep materials and equipment clean and dry, free from deterioration by weather elements, painting, plaster, etc., until the project is completed.
 3. Do not install damaged or defective materials.
 4. Touch up any damage from rust, paint, etc., and scratched or marred finishes on equipment to match original finish or completely refinished to restore equipment to original condition.
- B. Provide protect of any previously finished area from mars or other damage when an installation or connection of equipment requires work in areas previously finished by other Contractors.,
 1. The Contractor shall provide drop cloths, or any other materials necessary to protect floors, walls, furniture, equipment, etc. from soil or damage.
- C. Contractor shall arrange with other Contractors for promptly repairing and refinishing any damage to the building or its contents incurred by the installation or testing of the systems installed at no charge to the Owner.
- D. Where insulated piping extends to exposed areas, or to weather exposed areas, provide finish or jacket as specified in section 22 07 19.
- E. Contractor may weld in the existing buildings under an approved fire watch and other required safety measures.
 1. Contractor's work, and construction means, methods, materials, and equipment used shall not compromise the building fire safety, as well as safety and welfare of coworkers and building occupants.

3.10 PLUMBING IDENTIFICATION

- A. Identification of plumbing systems shall be as specified in Section 22 05 53 PLUMBING IDENTIFICATION.

3.11 WIRING AND ELECTRICAL WORK FOR PLUMBING EQUIPMENT

- A. All electrical work, equipment, and wiring shall comply with NEC.
- B. The Plumbing Contractor, unless specified otherwise, shall furnish all Division 22 equipment.
- C. Division 26 shall provide power services for equipment furnished by Plumbing Contractor to include safety disconnect switches, wiring, and final connections.

- D. The Plumbing Contractor shall check all electrical service and control connections to ensure proper operation of equipment and systems installed under work in Division 22.

3.12 EXCAVATING TRENCHING AND BACKFILLING

- A. Provide excavation necessary for water supply, sanitary, and storm piping, etc., and backfill such trenches and excavations after the installation, testing, and approval of work.
 - 1. Take care in excavating, that walls and footings and adjacent load bearing soils are not disturbed, except where lines must cross under a wall footing.
 - 2. Where a line must pass under footing, make the crossing by the smallest possible trench to accommodate the pipe.
 - 3. Keep excavation free from water by pumping if necessary.
 - 4. Do not open any greater length of trench, in advance of pipe or utility installation, than that authorized.
- B. Trenches for piping and utilities located inside foundation walls and five-foot outside of the wall shall be at less than 16" but no more than 24" wider than the outside diameter of the pipe.
 - 1. Site conditions shall govern the width of trenches for piping and utilities located more than five-feet outside of building foundation walls, except for sewers.
- C. Excavate trenches for sanitary and storm pipe may be laid at the proper alignment and depth and the maximum trench width at the outside top of the pipe is less than 24".
 - 1. Other trench widths governed by site conditions.
- D. Shape the trench bottom so that when pipe is in place the lower fourth of the circumference for the full length of the barrel is supported on compacted-fill.
 - 1. Dig bell holes so that no part of the weight of the pipe is supported by the bell, and not larger than necessary for proper jointing.
 - 2. Excavate all piping requiring excavation below the compacted fill required for the structure to at least 6" below pipe invert.
- E. Make trenches true to grade by means of substantial and accurately set batter-boards.
- F. Immediately after testing and/or inspection, carefully backfill the trench with earth free from clods, brick, etc., to a depth one-half the pipe diameter and then firmly puddle and tamp in such a manner as not to disturb the alignment or joints of the pipe.
 - 1. Thereafter, puddle and tamp the every vertical foot.
- G. Burial depth of gravity drain lines shall have precedence over non-gravity systems.
 - 1. Offset chilled water and domestic water lines as required to coordinate with gravity lines.
- H. The Contractor shall coordinate exact location, depth, and scope of underground piping, electrical conduits, and similar utilities.
 - 1. Routing shown on drawings is schematic coordinate actual routing with field conditions, grades, and work of other trades, then document in "as-built" drawings.

3.13 ANCHORING EQUIPMENT

- A. Securely anchor all equipment designed for permanent mounting to its supporting surface in compliance with IMC.
- B. A minimum of two bolts are required per each piece of equipment.
 - 1. Bolts shall be of sufficient size to prevent equipment from overturning or moving from original mounting position.

3.14 CORROSION

- A. Make provisions to prevent corrosion due to contact of metallic pipe and equipment with moisture or dissimilar materials.
- B. When joining a pipe with another pipe, valve, fitting, or piece of equipment constructed of dissimilar metal install an insulated joint to prevent formation of galvanic couple.
- C. Pipe hangers and supports of dissimilar metal shall be isolated from contact with pipe.

- D. Metal pipe and equipment shall be isolated from direct contact with concrete or other corrosive materials and soils.

3.15 TESTS

- A. Test all materials, equipment, and systems that require testing by these specifications or by any applicable regulation or code, in the presence of owner or authority having jurisdiction.
 - 1. Test all items requiring pressure or leakage tests before concealing from view.
 - 2. Rectify all defects disclosed by tests and the repeat the tests.
 - a. Continue process until installation passes all required test.
 - 3. The Contractor shall provide all labor, materials, and equipment used in tests.
- B. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements.
 - 1. Refer to Section 22 05 05, Plumbing Commissioning, for further details.

3.16 COMPLETION OF WORK

- A. Prior to acceptance of the installation and final payment of the Contract, the Contractor shall provide and complete the following:
- B. CLEANING: as required by Special Conditions applicable to this Division of the work.
 - 1. At the conclusion of the construction, the site and structure shall be cleaned thoroughly of all debris and unused materials remaining from the plumbing construction.
 - a. Clean all areas and temporary storage spaces of all packing boxes, wood frame members and other waste materials used in the plumbing construction.
 - 2. Clean the entire piping system and equipment internally.
 - 3. Drain all tanks fixtures and pumps and prove free of sludge and accumulated matter.
 - 4. Remove all temporary labels, stickers, etc. from all fixtures and equipment.
 - a. (Do not remove permanent nameplates, equipment model numbers, ratings, etc.).
- C. OPERATION AND MAINTENANCE MANUALS
 - 1. Refer to Section 01 91 00 – Commissioning for Operations and Maintenance Data requirements.
- D. AS-BUILT PRINTS:
 - 1. Requirements and methods of preparing and procedure for submitting project record as-built prints shall be in accordance with Division 1.
 - 2. Contractor shall keep day-to-day records of all changes (redline drawings), and upon completion of the work, shall submit the redline drawings to the A/E to incorporate these changes into the original ACAD drawing files in order to create the record drawings (as-built drawings).
 - a. Provide a CD containing -copies of all as-built drawing files in both ACAD and TIF format to the Owner at the date of substantial completion.
 - 3. The drawings shall show:
 - a. All equipment and piping (including underground).
 - b. The fire protection sprinkler system layout with dimensions and reference points.
 - c. All other concealed non-accessible work,
 - i) Branching arrangement and valve location for piping systems.
 - ii) The locations of all water hammer arrestors and potable water shutoff valves in system.
 - iii) The locations of control system sensors and other control devices.
 - iv) Work of change orders not shown on contract documents.

E. WARRANTY

1. The warranty for all plumbing equipment (whether manufacturer's or contractor's warranty) shall comply with Section 01 78 00.
2. All equipment and systems, unless specified otherwise, shall have a manufacturer's warranty for a period of one year from the date of substantial completion.
 - a. This warranty shall be against defective materials, design, and workmanship.
3. The plumbing contractor shall repair or replace any component of the Division 22 work under warranty, which proves to be defective, at no cost to the Owner.
4. The Contractor upon receipt of notice from the Owner of a failure during the warranty period shall respond the same day and complete warranty service work in a timely manner.
5. During warranty period, document all responses to warranty calls made by the Contractor by leaving a copy of the mechanics service ticket with the school Principal upon completion of the warranty work, prior to leaving the site.
 - a. Without proper documentation, the Owner cannot acknowledge repairs are complete.
6. Required optional extended manufacturer or vendor warranties for specific items, their performance, or expected durability will be explicitly included in Division 22 Specifications.
 - a. Manufacturer or vendor shall repair or replace any defective component under extended warranty at no cost to the Owner.

3.17 DEMONSTRATION AND TRAINING

- A. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative.
- B. Provide competent, factory-authorized personnel to provide instruction to Facilities Service personnel concerning the location, operation, and troubleshooting of the installed systems.
- C. Schedule the instruction in coordination with the Owner's Representative after submission and approval of formal training plans.
- D. Refer to Section 22 05 05, Plumbing Commissioning, for further contractor training requirements.

END OF SECTION

SECTION 22 10 00
PLUMBING PIPING

PART 1 GENERAL

1.1 SCOPE

- A. Work consists of all plumbing work indicated on drawings and specified herein.
- B. Included are requirements for fees/permits for installation and inspection of all plumbing work.
- C. Also see "Instructions to Bidders," "General Conditions," "Supplementary General-Conditions," "Special Conditions," and "General Requirements for Mechanical and Electrical Work" which are hereby made part of this section and govern in the event there is a conflict with this section.

1.2 SECTION INCLUDES

- A. Pipe and pipe fittings
- B. Valves
- C. Sanitary sewer piping system
- D. Domestic water piping system
- E. Storm water piping system
- F. Natural gas piping system

1.3 REFERENCES

- A. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings Class 150 ns 300
- B. ANSI/ASME B16.18 – Cast Copper Alloy Solder Joint Pressure Fittings
- C. ANSI/ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
- D. ANSI/ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV
- E. ANSI/ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV
- F. ANSI/ASME Sec. 9 - Welding and Brazing Qualifications
- G. ANSI/ASTM B32 - Solder Metal
- H. ANSI/ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe Fitting, Schedule 40
- I. ANSI/AWS D1.1 - Structural Welding Code
- J. ASME - Boiler and Pressure Vessel Code
- K. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless
- L. ASTM A74 - Cast iron Soil Pipe and Fitting
- M. ASTM A120 - Pipe, Steel, Black and Hot-Dipped Zinc Coated (Galvanized), Welded and Seamless, for Ordinary Uses
- N. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and elevated Temperatures
- O. ASTM A395 – Ferritic Ductile Iron Pressure Retaining Castings
- P. ASTM A536 Ductile Iron Castings
- Q. ASTM B88 - Seamless Copper Water Tube
- R. ASTM B306 - Copper Drainage Tube (DWV)
- S. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings
- T. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- U. ASTM D2235 - Solvent Cement for Acrylonitrile - Butadiene - Styrene (ABS) Plastic Pipe and Fittings
- V. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR)
- W. ASTM D2513 - Thermoplastic Gas Pressure Pipe, Tubing and Fittings
- X. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) Composite-Sewer Piping
- Y. ASTM D2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe
- Z. ASTM D2729 - Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- AA. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Piping and Fittings

- BB. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
- CC. ASTM D3033 - Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- DD. ASTM D3034 -Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- EE. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- FF. AWS A5.8 - Brazing Filler Metal
- GG. AWWA C601 - Standard Methods for the Examination of Water and Waste Water
- HH. AWWA C606 – Grooved and Shouldered Joints
- II. CISPI 301 - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems
- JJ. ASTM D635 - Flame Retardant

1.4 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME and applicable state labor regulations.
- C. Provide Welder Certification in accordance with ANSI/ASME Sec. 9.

1.5 SUBMITTALS

- A. Submit product data under provisions of Section 01 33 00.
- B. Include data on pipe materials, pipefittings, valves, and accessories.

PART 2 PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED WITHIN 5-FEET OF BUILDING

- A. See section 22 05 00 part 2.1 f for additional material requirements.
- B. Cast Iron Pipe: ASTM A74 service weight
 - 1. Fittings: Cast iron
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets.
- C. Copper Tubing: ASTM B306, DWV
 - 1. Fittings: ANSI/ASME B16.3, cast bronze, or ANSI/ASME B16.29, wrought copper
 - 2. Joints: ANSI/ASTM B32, solder, Grade 50B
- D. PVC Pipe: ASTM D2665
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2855, solvent weld

2.2 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74 service weigh
 - 1. Fittings: Cast iron
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets
- B. Cast Iron Pipe: CISPI 301, Hubless service weight
 - 1. Fittings: Cast iron
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies
- C. Copper Pipe: ASTM B306, DWV
 - 1. Fittings: ANSI/ASME B16.3, cast bronze, or ANSI/ASME B16.29, wrought copper
 - 2. Joints: ANSI/ASTM B32, solder, Grade 50B
- D. PVC Pipe: ASTM D2665
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2855, solvent weld (Not allowed in plenums)

2.3 WATER PIPING, BURIED WITHIN 5-FEET OF BUILDING

- A. Copper Tubing:
 - 1. ASTM B88, Type K, hard drawn
 - 2. Fittings:
 - a. Soldered: ANSI/ASME B16.29, wrought copper

- b. Pressed: ASME B16.18 or ASME B16.22, copper press fitting with EPDM O-ring
- 3. Joints:
 - a. Soldered: ANSI/ASTM B32, solder, Grade 95TA
 - b. Pressed: ASME B16.18 or ASME B16.22, copper press fitting with EPDM O-ring

2.4 WATER PIPING, ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L, hard drawn
 - 1. Fittings:
 - a. Soldered: ANSI/ASME B16.18 - bronze sand casting, ANSI/ASME B16.22 - wrought copper, ANSI/ASME B16.23 - cast brass, or ANSI/ASME B16.29 - wrought copper.
 - b. Pressed: ASME B16.18 or ASME B16.22, copper press fitting with EPDM O-ring
 - 2. Joints:
 - a. Soldered: Grooved joints or ANSI/ASTM B32, solder, Grade 95TA
 - b. Pressed: ASME B16.18 or ASME B16.22, copper press fitting with EPDM O-ring

2.5 STORM WATER PIPING, BURIED WITHIN 5-FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 service weight
 - 1. Fittings: Cast iron
 - 2. Joints: Hub-and spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets
- B. Cast Iron Pipe: CISPI 301, Hubless, service weight
 - 1. Fittings: Cast iron
 - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies
- C. PVC Pipe:
 - 1. ASTM D2665
 - 2. Fittings: PVC
 - 3. Joints: ASTM D2855, solvent weld

2.6 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe:
 - 1. ASTM A74 service weight
 - 2. Fittings: Cast iron
 - 3. Joints: Hub-and spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets
- B. Cast Iron Pipe:
 - 1. CISPI 301, Hubless, service weight
 - 2. Fittings: Cast iron
 - 3. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies
- C. PVC Pipe: ASTM D2665
 - 1. Fittings: PVC
 - 2. Joints: ASTM D2855, solvent weld (Not allowed in plenums)

2.7 GAS PIPING, BURIED BEYOND 5-FEET OF BUILDING

- A. Steel Pipe: ASTM A53 or A120, Schedule 40 black
 - 1. Fittings: ASTM A234 forged steel welding type, with ANSI/AWWA C105 polyethylene jacket or double layer, half-lapped 10-mil polyethylene tape.
 - 2. Joints: ANSI/AWS D1.1, welded
- B. Plastic Tubing: ASTM D2513 Thermoplastic Gas Pressure Tubing
 - 1. Fittings: ASTM 3350 Polyethylene
 - 2. Joints: ASTM D2683, Specification for Socket-type Polyethylene (PE) Fittings for Outside Diameter Controlled Polyethylene Pipe; or ASTM D3261, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Pipe and Tubing ; or ASTM F1055, Specification for Electrofusion Type Polyethylene Fittings

2.8 NATURAL GAS PIPING, BURIED WITHIN 5-FEET OF BUILDING

- A. Steel Pipe: ASTM A53 or A120, Schedule 40 black
 - 1. Fittings: ASTM A234 forged steel welding type, with ANSI/AWWA C105 polyethylene jacket or double layer, half-lapped 10-mil polyethylene tape.
 - 2. Joints: ANSI/AWS D1.1, welded

2.9 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53 or A120, Schedule 40 black
 - 1. Fittings: ANSI/ASME B16.3, malleable iron, or ASTM A234, forged steel welding type.
 - 2. Joints: Screwed for pipe 2" and under; ANSI/AWS D1.1, welded, for pipe over 2".
- B. Copper Tubing: ASTM B88, Type L, hard drawn
 - 1. Fittings: ANSI/ASME B16.23, cast brass, or ANSI/ASME B16.29, wrought copper
 - 2. Joints: ANSI/ASTM B32, solder, grade 95TA

2.10 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size 2" and under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.
- B. Pipe Size Over 2": 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; neoprene gaskets for gas service; 1/16" thick preformed neoprene bonded.
- C. Grooved and Shouldered Pipe End Couplings: Ductile iron housing clamps to engage and lock, where required, designed to permit some angular deflection, contraction, and expansion; 'C' shape pressure responsive synthetic rubber sealing gasket conforming to ANSI/NSF-61; steel bolts, nuts and washers; galvanized couplings for galvanized pipe.
 - 1. IPS Steel Piping:
 - a. Rigid Type: Use coupling housings cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9 and NFPA 13.
 - b. Flexible Type, use in locations where vibration attenuation and stress relief are required.
 - i) May use flexible couplings in lieu of flexible connectors at equipment connectors.
 - ii) Place couplings in close proximity to the vibration source.
 - c. Flange Adapters: Flat face, for direct connection to ANSI Class 125 or 150 flanged components.
 - 2. Hard Copper Tube: Housings cast with offsetting angle-pattern bolts pads.
 - a. Housings coated with copper colored alkyd enamel.
 - b. Manufacture to copper tube dimensions with FlushSeal® type gasket.
- D. Dielectric Connections: Union or waterway with galvanized or plated steel threaded end, copper solder end, steel or ductile iron grooved end, and water impervious isolation barrier.

2.11 GATES VALVES

- A. Up to 2": Bronze body, inside screw, single wedge, or disc, threaded ends, valves in copper pipe to have soldered joint ends.
- B. Over 2": Iron body, bronze trim, rising OS&Y, single wedge, flanged ends.

2.12 GLOBE VALVES

- A. Up to 2": Bronze body, rising stem and hand wheel, inside screw, renewable composition disc, screwed ends, with back seating capacity.
- B. Over 2": Iron body, bronze trim, rising stem and hand wheel, OS&Y, plug-type disc, flanged ends.

2.13 BALL VALVES

- A. Up to 2":
 - 1. Bronze body, stainless steel ball with Teflon seats and stuffing box ring, lever handle.
 - 2. Valves in copper pipe use soldered joint ends or end compatible with piping system.

- B. Over 2":
 - 1. Cast steel body; chrome plated steel ball, Teflon seat and stuffing box seals, lever handle.
 - 2. Ductile iron body; chrome plated carbon steel ball and stem, Teflon seat, lever handle.

2.14 GAS COCKS

- A. Up to 2": Use bronze body, bronze tapered plug, non-lubricated, Teflon packing, threaded ends.
- B. Over 2": Use cast iron body and plug, non-lubricated, Teflon packing, flanged ends.

2.15 SWING CHECK VALVES

- A. Up to 2" use bronze 45° swing disc with solder screwed ends.
- B. Over 2" use iron body, bronze trim, 45° swing disc, renewable disc, and seat, flanged ends.
- C. 2" through 4" use ductile iron, stainless steel trim, swing disc, stainless steel clapper, grooved ends.

2.16 SPRING LOADED CHECK VALVES

- A. Iron body, bronze trim, spring loaded, renewable composition disc, screwed, wafer, or flanged ends.
- B. Ductile iron body, stainless steel trim, spring-assisted, aluminum bronze, or elastomer encapsulated ductile iron disc, grooved ends.

2.17 RELIEF VALVES

- A. Bronze body, Teflon seat, steel stem, and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

2.18 ACID WASTE PIPING, BURIED

- A. High Silicon Iron Pipe: ASTM A861
 - 1. Fittings use bell and spigot joints with acid resistant sealant.
- B. Polypropylene Pipe: ASTM D2467, D4101
 - 1. Fittings: Polypropylene ASTM D1785
 - 2. Joints: Thermofused
- C. CPVC Pipe: ASTM D1784
 - 1. Fittings: CPVC
 - 2. Joints: ASTM F493 Solvent weld (acid grade solvent with yellow die)

2.19 ACID WASTE PIPING, ABOVE GRADE

- A. High Silicon Iron Pipe: ASTM A861
 - 1. Fittings use bell and spigot joints with acid resistant sealant.
- B. Fire Resistant Polypropylene Pipe: ASTM D2467, D4101
 - 1. Fittings use polypropylene ASTM D1785 and joints use Thermofused
- C. CPVC Pipe: ASTM D1784
 - 1. Fittings: CPVC and Joints ASTM F493 Solvent weld (acid grade solvent with yellow die).
- D. Borosilicate Glass Pipe Fittings: Plastic ASTM D2146, or Glass Fittings: Compression

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends, and remove burrs.
- B. Remove all scale and dirt on inside and outside of pipe and connectors before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- B. Route piping in orderly manner and maintain gradient.
- C. Install piping to conserve building space and not interfere with use of space.
- D. Group the piping at a common elevation and location whenever practical.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide clearance for installation of insulation and access to valves and fittings.
- G. Provide access where valves and fittings are not exposed.
- H. Arrange water piping to drain at low points.
- I. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.
 - 1. Slope piping and arrange to drain at low points.
- J. When welding pipe support members to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to weld.
- K. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.
- L. Install bell and spigot pipe with bell end upstream.
- M. Install valves with stems upright or horizontal, not inverted.
- N. Install a hose bibb on one lavatory (minimum) per group restroom.
- O. Paint all LP and natural gas piping yellow and provide identification label.
- P. Fire Sprinkler Piping:
 - 1. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer, and the grooving tools shall be of the same manufacturer.
 - 2. Use gaskets molded and produced by the groove-coupling manufacturer.
 - 3. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
 - 4. Grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products.
 - 5. Factory trained representative shall periodically inspect the product installation.
 - 6. Contractor shall remove and replace any improperly installed products.
 - 7. Use pipe certified for use with the manufacturer's system.

3.3 APPLICATION

- A. Use an approved mechanical couplings and fasteners only in accessible locations or as approved by engineer.
- B. Install unions or grooved joint couplings downstream of valves at equipment or apparatus connections.
- C. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Install globe or ball valves for throttling, bypass, or manual flow control services.
- E. Provide spring loaded check valves on discharge of water pumps.

3.4 DISINFECTION OF POTABLE WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed, and clean.
- B. Ensure PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form, throughout system to obtain 50-to 80-mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15% of outlets.
- E. Maintain disinfectant in system for 24-hours.
- F. If final disinfectant residual tests less than 25-mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water of 1.0-mg/L.
- H. Take samples no sooner than 24-hours after flushing, from 5% of outlets and from water entry, and analyze in accordance with AWWA C601.

END SECTION

SECTION 26 00 10

SPECIAL PROVISIONS FOR ELECTRICAL WORK

PART 1 GENERAL

1.1 WORK INCLUDED:

- A. Furnish all labor, materials, equipment, tools and services in connection with, or properly incidental to the furnishing of equipment, installing equipment and the construction of electrical systems as described in this Division of the Specifications and/or shown on the accompanying Drawings, or reasonably implied there from, except as hereinafter specifically excluded.
- B. Furnish all additional details or special construction as required for work indicated or specified in the division or work specified in other divisions. Furnish and install all material and equipment usually furnished with systems or required to complete and make operative the installation, whether specifically mentioned or not.
- C. Owner-furnished equipment shall be installed and connected in accordance with manufacturer requirements.

1.2 REFERENCE DOCUMENTS:

- A. The Electrical Drawings are a combination of scale and symbolic representation of the electrical systems required to be installed. The drawings and specifications are based on qualified skilled craftsmen procuring and installing the work. The drawings include symbolic indication of branch circuit conductors, connections to devices, hook-up of electric powered equipment, etc.
- B. Division 26 Work includes proper routing of raceways, grouping of conductors, wiring to and hook-up of devices and equipment in accord with the total provisions of the specifications. Refer to the symbol schedule for the basis of the drawing representation. Symbols other than those in the schedule are explained elsewhere or are those commonly used in the industry. Listing of a symbol in the schedule does not imply that the symbol is used on the final contract documents. The electrical drawings indicate general locations of devices and equipment, but final locations shall be determined in reference to the Architectural, Structural, Mechanical and Electrical Drawings.
- C. The Architectural, Structural and Mechanical Drawings and Specifications including all Supplements issued thereto, are a part of these Specifications and the accompanying Electrical Drawings, and shall be complied with in every respect.
 - 1. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
 - 2. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.3 REGULATIONS, PERMITS AND APPROVALS:

- A. The installation including all materials and equipment shall conform to the most recent NFPA 70 adopted by the Authority Having Jurisdiction; the applicable requirements of the utility companies supplying energy, communications and other services to the project; the laws of the City pertaining to electrical installation; and with all national, state and local codes and laws relating to construction, building and public safety.
- B. Each of the above regulations are minimum standards. Where the requirements of these minimum standards are less than or do not conflict with the requirements of the Contract Documents, the Contract Documents shall be followed.
- C. Obtain all permits and arrange for all inspections and approvals for the work including

construction document review and site observations by the authorities having jurisdiction. Obtain certificates of inspection and acceptance and transmit these to the Architect as a condition of acceptance. Assume and pay all fees and other costs involved in obtaining the permits, inspection certificates and approvals as a part of Division 26 Work.

1.4 SHOP DRAWINGS AND OTHER SUBMITTAL:

- A. Submit Shop Drawings or fully descriptive catalog data for all items of materials and equipment proposed to be furnished and/or installed. Submit sufficient copies to provide reviewed copies as need to be returned plus three (3) copies for retention by the Architect per Section 01 30 00 - Submittal Procedures.
- B. Submit on all Electrical Distribution Equipment, wiring materials, lighting fixtures and all components of communication, signal, protection and alarm systems. The submittal of free standing electrical equipment shall include scale drawings indicating the proposed layout of this equipment within the space allocated and the proximity of existing work, other electrical work, and work installed under other divisions of work.
- C. Submit sufficiently early to allow ample time for checking without delaying delivery of the materials to job site. A review of any submittal which results in a requirement to resubmit shall not be justified basis of work delay or extra cost.
- D. The review of Shop Drawings or catalog data by the Architect shall not negate the Contractor's responsibility for deviations from the Drawings and Specifications unless, in writing, attention is specifically noted for such deviations at the time of submission and acceptance of the Architect is noted thereon. When attention is called to deviations from the Drawings and Specifications, state in letter of transmittal whether or not such deviations involve any change in contract time and cost. Errors of any kind associated with submittal shall be the responsibility of the installer of Division 26 Work.

1.5 STANDARDS FOR ELECTRICAL MATERIALS:

- A. Materials shall be new and free from defects and shall conform with the standards of the Underwriters' Laboratories, Inc., in every case where such standards have been established. Evidence of such conformance shall be the UL label or "listing" by Underwriters' Laboratories, Inc. under Re-examination Service.
- B. The Specifications indicate a standard of quality for materials. Manufacturer's names and catalog numbers are used to designate materials or equipment to establish grade and quality. Where several manufacturers are named, the bid shall be based on those named manufacturer's products. Where only one manufacturer is named, unless stated otherwise, manufacturers of equal quality products will, however, be considered as substitutions only if submitted at least 5 days before the bid date.

1.6 SUBSTITUTIONS:

- A. In the event substitutions are to be submitted for Owner review, furnish descriptive catalog material, test data, samples, etc., of both the specified material and the proposed substitute, as well as any other pertinent data necessary to demonstrate that the proposed substitutions are acceptable equals to the specified products. Substitutions: 01 60 00 - Product Requirements
- B. Substitutions shall not be made without written acceptance and the lack of acceptance shall not be basis of change in the work.

PART 2 PRODUCTS

2.1 PAINTS AND PROTECTIVE COATINGS:

- A. For exposed hangers and supports: not provided with factory protected finish: Sherwin-Williams Kromik primer and Metalatex semi-gloss enamel.
- B. Materials and Equipment: Sherwin-Williams Kromik primer and Metalatex semi-gloss enamel.

2.2 NAMEPLATES:

- A. Nameplates shall be laminate plastic name plates with one-fourth inch (1/4") high letters engraved thereon which give contract identification, electric service characteristics and source of power on each of the items of equipment. Nameplates for items of equipment, on Life Safety System including transfer switches shall be red with white letters and all others shall be black with white letters unless specifically noted otherwise.
- B. Name plates shall be fastened on with cadmium or plated screws.

PART 3 EXECUTION

3.1 EXAMINATION OF SITE:

- A. Visit the site of the proposed work and carefully examine the existing conditions and limitations thereof, and include in the bid all costs of any kind whatsoever which are incurred through limitations of the existing conditions.

3.2 SERVICE, CONNECTIONS AND PERMITS:

- A. Obtain all permits, inspections and approvals for the work including construction document review and site observations by the authorities having jurisdiction. Obtain certificates of inspection and acceptance and transmit these to the Architect as a condition of acceptance. All fees and other costs involved in obtaining these permits, inspections and approvals shall be assumed and paid under the Division of the Work.
- B. Arrange for all services and pay all costs whatsoever to completely install and place in operation these electrical systems.

3.3 COORDINATION:

- A. Coordinate work with that of other trades and adjacent projects to make proper connections at appropriate locations and times. Review the construction of other trades and adjacent projects to determine the physical needs and time requirements imposed in providing connections to them as shown on the drawings and in accordance with the project schedule.
- B. Coordinate work with that of the other trades so work may be installed in the most direct and workmanlike manner without hindering or handicapping the other trades. Give precedence to lines which require a stated grade for proper operation. Where space requirements conflict, the electric conduit shall, in general, yield to all other trades.
- C. When any electrical equipment is operable and it is to the advantage of the project, the equipment may be operated providing that prior approval of the Owner is received and proper supervision of the equipment operation performed. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner. Regardless of whether the equipment has or has not been operated, properly maintain the equipment; and at the completion of the work, properly clean, adjust, and complete all items before final acceptance is requested.

- D. The Architect or others may, during the execution of the work, desire to make connections to or modifications of work installed in this Division of Work. Permission for the Architect or others to make these connections or modifications shall be granted without relieving responsibility for work installed under this Division of Work.

3.4 RECORD DRAWINGS AND BROCHURES:

- A. During the execution of work, maintain a complete set of reproducible drawings upon which all dimensional locations of equipment, deviations and changes in the work shall be recorded. These Record Drawings shall be in good condition and shall be marked "Record Drawings", signed, dated and transmitted with two sets of prints under a transmittal letter to the Architect upon completion and acceptance of the work and before final payment is made. Refer to Section 01 78 00 - Execution and Closeout Requirements.
- B. Unless otherwise noted, provide at a minimum the following data as applicable to the work shall be included in items furnished for use by the Owner:
 - 1. Record Drawings as specified above and elsewhere.
 - 2. Four (4) brochures of lighting fixtures with copies of data of each installed luminaire. Index each brochure indicating fixture type, manufacturer and catalog number, voltage, and lamping.
 - 3. Four (4) brochures of Electrical Distribution Equipment with final drawings, operating instructions and maintenance instructions.
 - 4. Four (4) brochures each for communication, signal protection and alarm systems installed with final installation and connection diagrams; and equipment operating, test and maintenance instructions.

3.5 CARE AND CLEAN UP OF EQUIPMENT AND MATERIALS:

- A. Protect each item and component of electrical equipment from moisture, concrete, mortar, paint, dust and other foreign materials from the time it arrives on the job site until installed, placed in service and accepted by Owner, using signs, barriers and other means where by others are made fully aware of the importance of protecting equipment from damage.
- B. Keep all electrical construction materials clean of all foreign materials from the time of arrival on the site until their installation. Time the installation of each item to avoid unnecessary exposure of the materials to destructive elements or destructive environment. Clean all installed materials of all foreign materials including concrete, mortar, spilled paint, and dust prior to final inspection. All unused electrical construction materials shall be removed from the site.
- C. After the installation is complete and before equipment is energized, thoroughly clean the interior and exterior of all equipment and materials. After the building is completed and cleaned, arrange for a power outage on each item of equipment and repeat the cleaning. This cleaning shall be performed just before final inspection. Each component shall be cleaned with air pressure, vacuumed and wiped clean of all dust and other foreign material. Components shall be cleaned of all oxidation. Any portion needing touch-up finishing and/or protective coating shall be so finished to equal the specified finish on the product.
- D. Provide for the removal of all unused, scrap, material containers and other rubbish or trash resulting from Division 26 Work from within and around all work and work areas on a basis that it will not interfere with other trades, other work or the completion of any work.

3.6 PAINTING AND PROTECTION:

- A. Electrical equipment such as primary switches, switchboards, panelboard fronts, motor control centers and transformers shall be delivered to the job with suitable factory finish. Finishes marred in transit or during installation shall be refinished under this Division of Work to present a neat, workmanlike appearance equal to the factory finish.

- B. Except as elsewhere required, painting of equipment, boxes, conduit, etc., furnished under this Contract will be performed under another division of work. Clean electrical work of all trash, dirt, marks, and other foreign materials under this Division of Work prior to the application of finishes.
- C. Electric work in areas of the construction to remain unpainted shall be protective finished under this Division of Work as follows unless indicated otherwise:
 - 1. Paint all exposed and non-rust inhibited hangers and supports not provided with a factory finish with primer and two (2) coats of enamel.
 - 2. Material and equipment with suitable factory-applied finishes may be left unpainted provided the Architects' approval to do so is obtained. Prime and paint material and equipment that does not obtain such approval with two (2) coats of semi-gloss enamel.
- D. Painting in finished areas of the construction where finished coatings are applied under other divisions of work shall be performed under other Division of Work and shall include:
 - 1. All exposed hangers and supports and all exposed conduits and boxes with a coat of primer, and two (2) coats of semi-gloss enamel and all panel boards and other cabinets with two (2) coats of semi-gloss enamel.
 - 2. Concrete foundations with one (1) coat of masonry paint and one (1) coat of enamel.
 - 3. Equipment with suitable factory-applied finishes left unpainted provided Architect approval is obtained prior to beginning of painting in the area. Material and equipment that does not obtain such approval shall be primed and painted two (2) coats of enamel.
- E. Painting done shall be in colors designated by the Architect. Successive coats of paint shall be of different shades.

3.7 CUTTING AND PATCHING:

- A. Do all cutting necessary for the installation of Division 26 Work. Cutting shall be carefully and neatly done so as not to damage or cut away more than necessary.
- B. Where Division 26 workmen damage or cut away work excessively, patching will be performed as a part of Division 26 Work. Patching will be by craftsman experienced in performing this type of work.

3.8 NAMEPLATES:

- A. Install nameplates which give contract drawing identification and electric service characteristics on equipment unless specifically indicated otherwise including switch gear, switch boards, transformers, panel boards, and main control cabinets for alarm systems. Typed directories shall be provided for branch panel boards.
- B. In each case where compartments, equipment, etc., are required to be "labeled" or "identified", it shall be construed that nameplates are to be installed.
- C. Locate nameplates on the exterior face of the equipment so as to be clearly visible when the equipment is in place.
- D. Fasten nameplates on with screws except contact-type permanent adhesive shall be used where screws cannot or should not penetrate enclosure or substrate.

3.9 TESTS:

- A. On completion of the work, make voltage, resistance and ground tests of all wiring installed under this Contract.
- B. Such tests shall show results in accordance with the requirements of the Code. See specific items for other specific test requirements.
- C. Any defect found shall be repaired under this Contract to the satisfaction of the Architect.

3.10 GUARANTEE:

- A. Warranty all work done and all materials and equipment furnished to be free from defects.
- B. Promptly repair or replace defective work, material and equipment without charge to the Owner at a schedule suitable to the Owner.
- C. The warranty shall be for a period of one year after acceptance for beneficial use by the Owner unless otherwise indicated elsewhere.

END OF SECTION

SECTION 26 01 10

RACEWAYS

PART 1 GENERAL

1.1 WORK INCLUDED:

- A. Furnish and install complete systems of raceways for the installation of electrical conductors and other materials as specifically indicated.
- B. Provide complete raceway systems for each conductor of electric power, to be installed in this division of the work and for other work where so indicated except as specifically indicated otherwise.

1.2 REFERENCE DOCUMENTS:

- A. The Special Provisions for Electrical Work are hereby made apart of this section of the work. Refer to Section 26 00 10.
- B. See Section 26 01 90 for Supporting Devices.
- C. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- D. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.3 SUBMITTALS:

- A. Submit complete information including manufacturer, material, and finish on each type of raceway and supports to be installed. See Section 01 30 00 - Submittal Procedures: Submittal procedures.

1.4 QUALITY ASSURANCE:

- A. Each raceway shall bear the UL Label where UL Standards have been established for the type of raceway being provided. See Section 01 60 00 - Product Requirements.
- B. Each raceway shall be suitably protective coated for the installation and each portion of the protective coating that is damaged during receiving, handling and installation shall be refinished equal to factory protection.

PART 2 PRODUCTS

2.1 MATERIALS:

- A. Raceways include conduits, ducts, wireways, gutters, boxes, fittings, and similar items as indicated in other sections of the work.
- B. Raceways fabricated for special pull boxes, junction boxes, gutters, and similar connections shall be code-gauge steel fully rust inhibited and finish painted to match adjacent switch-gear. Interiors shall be accessible through screw covers. Supports and interior protection shall be provided for conductors.

2.2 SLEEVES:

- A. Sleeves shall be galvanized steel, formed to meet the size and shape of the raceway to pass through the sleeve.
- B. Sleeves for conduits through exterior walls shall be galvanized steel, Schedule 40 pipe or conduit.
- C. Sleeves for conduits through interior walls that are not subject to moisture may be

- non-metallic conduit.
- D. Sleeves through waterproof walls, floors and roofs shall be provided with water-stop flanges at the point of waterproofing membrane.
 - E. Sleeves through waterproof floors shall be as specified for exterior walls below grade except that the collar shall be located at the level of the waterproofing membrane.
 - F. Sleeves through the roof shall be as specified for waterproof floors plus a galvanized iron pitch pan around the sleeve.
 - G. Sleeves through fire-rated construction shall be non-combustible.

2.3 PITCH PANS:

- A. Pitch pans shall be galvanized steel pans of the shape of the raceway passing through the waterproofing membranes, of the size to provide 1" to 2" space between the outside of the raceway and the vertical side of the pan and of a depth to be set on the waterproofing membrane and extend 1" above the finished roof.

2.4 SMOKE AND FIRE STOP SEALANT:

- A. Smoke and fire stop sealant caulk shall be 3M Company Type or pre-approved equal. Larger openings shall be stuffed with 3M Company fire barrier composite in accordance with the manufacturer's directions. Silicone foam penetration sealant shall be as approved for the installation.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. Each raceway shall be suitably supported from, installed and aligned with the main structural components of the building.
- B. Raceways shall be installed to avoid interference with work of other trades.

3.2 PROTECTION AND CLEANING:

- A. Raceways will be cleaned both internally and externally of all dirt, debris, and other foreign materials. Raceways in areas to be finish-painted shall be cleaned properly prior to the painting. Raceways not indicated to be finish painted on the job shall be protected from foreign objects and materials during construction and cleaned and touch-up coated before completion of the work.

3.3 SLEEVES AND OPENINGS:

- A. Furnish and install sleeves in forms of walls, floor slabs, partitions and beams for the passage of raceways. Sleeves shall be securely fastened in position and trimmed to be flush with construction.
- B. Conduits in above grade outside walls shall be installed in the center of sleeves and the annular space filled with Oakum and sealed with asphalt. Sleeves through interior walls shall be filled with wall sealing material. Raceways passing through sleeves shall be fitted on each side of each interior wall with a round galvanized steel flange. Raceways that pass through waterproofed walls shall be sealed to forbid water passing through the conduit.
- C. Route wireways, and/or groups of conduits which pass through floors or interior walls through blocked out openings. After installation of raceways, fill the entire blocked-out area with material compatible with the floor or wall penetrated before finishing treatment is applied. Where fire and/or smoke rated construction is penetrated, penetrations shall

be sealed in accordance with sealant manufacturer's instructions. The completed installation shall maintain the fire-rating integrity of the construction.

- D. Furnish and install and coordinate with the Installer of the roof to provide pitch pans for all small raceways and curbed openings with flashing and counter flashing for large Division 26 Work passing through the roof.

END OF SECTION

SECTION 26 01 11
CONDUIT & FITTINGS

PART 1 GENERAL

1.1 WORK INCLUDED:

- A. Furnishing and installing of complete systems of electrical conduits as a part of the raceway systems for installation of conductors for electrical systems.

1.2 REFERENCE DOCUMENTS:

- A. The Special Provisions for electrical work are hereby made a part of this section of the work. Refer to Section 26 00 10.
- B. See Section 26 01 90 for Supporting Devices.
- C. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- D. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.3 SUBMITTALS:

- A. Submit complete manufacturers' specifications data on each type and manufacture of conduit and fitting proposed to be furnished and/or installed on the project. See Section 01 30 00 - Submittal Procedures.

1.4 QUALITY ASSURANCE:

- A. Conduits shall be in accord with ANSI Standard C 80.
- B. Each length of conduit shall bear the UL Label. See Section 01 60 00 - Product Requirements.

PART 2 PRODUCTS

2.1 RIGID METALLIC CONDUITS AND FITTINGS:

- A. Rigid metallic conduit shall be standard hot-dipped galvanized mild rigid steel. Conduit shall have galvanized threads. Each length shall be provided with a coupling and ends without couplings shall be furnished protected with a suitable covering. All bends in conduit one and one-quarter inch (1-1/4") in size and larger shall be made with factory manufactured elbows. Rigid metallic conduit shall be equal to Republic Galvite Rigid Steel Conduit.
- B. Locknuts and bushing shall be galvanized steel or approved equal molded canvas bakelite bushings may be used for 2" trade size. Bakelite insulated, lined steel bushings may be used for conduits two and one-half inches (2-1/2") and larger.

2.2 FLEXIBLE METAL CONDUIT AND FITTINGS:

- A. Flexible metal conduit shall be spirally wound galvanized steel.
- B. Terminators of flexible steel conduit shall be T & B or equal "Tite-Bite" insulated connectors and T & B or equal, "Tite-Bite" combination couplings.

2.3 SPECIAL FITTINGS:

- A. Split couplings shall be O.Z. or equal, Manufacturing Company Type SP.
- B. Expansion joints shall be O.Z. or equal, Manufacturing Company Type AX expansion joints with Type AJ bonding jumpers.
- C. Pull rope shall be 3/16" polyester stranded JET LINE rope.

2.4 RIGID PVC CONDUITS AND FITTINGS:

- A. Codes and standards shall conform with U.L.-651 and NEMA TC-2 and shall be listed and labeled by the Underwriters Laboratories Inc.
- B. PVC conduit and fittings shall be Schedule 40 unless marked Schedule 80, equal to Carlon systems. They shall be designed for use under ground, shall be non-conductive and shall assure a safe system. Conduits and fittings shall be non-corrosive, impervious to most chemicals, provide lower expansion and contraction features, and shall be suitable for direct earth burial or encasement in concrete.
- C. PVC conduit and fittings shall be rated for 90 degree centigrade conductors or cable, and for use in direct sunlight.

2.5 RIGID PVC FITTINGS:

- A. Codes applicable to PVC conduit shall also apply to PVC Fittings.
 - 1. Expansion couplings equal to Carlon E945 or E955 as required.
 - 2. Bell ends equal to Plus 80 or 40 plain bell for use with non-metallic solvent welds.
 - 3. Standard couplings socket type for solvent cement attachment.
 - 4. PVC rigid adaptors E942 or E943 threaded to metallic systems and socket attachment by solvent cement.

PART 3 EXECUTION

3.1 MATERIAL SELECTION:

- A. Raceways shall be standard galvanized steel rigid metal conduit unless otherwise indicated.
- B. Electrical Metallic Tubing (EMT) may be used for raceways above furred ceilings, within dry wall partitions, exposed in rooms with exposed construction and in mechanical and electrical rooms for sizes of four inch (4") and smaller.
- C. Wiring connections to motors, transformers, or other devices which are subject to vibration or require adjustment shall be flexible metallic conduit. The flexible conduit shall be more than 12 diameters but less than 18 diameters in length. Where these connections are outdoors, or in damp locations, or are connections to any kitchen or laundry type equipment, liquid-tight flexible conduit shall be used.
- D. Wiring to each recessed lighting fixture shall be run in an independent length of flexible conduit extended from an accessible junction box located above the ceiling. The flexible conduit shall be of sufficient length to allow the connection point to the fixture to drop at least 12" below the finished ceiling, and shall be at least 48" long but not more than 72" long.
- E. Recessed lighting fixtures which have UL approved prewired circuit junction boxes and fixture wire extensions may be used and wired directly to the branch circuit runs without the added flexible conduit connections.
- F. PVC Schedule 80 conduit shall be provided underground and under building supported by approved hangers. Conduit shall not be laid on top of the ground with no supports.
- G. Elbows shall be of the same materials as the conduit. Elbows in EMT and small rigid conduits may be job-fabricated with a bender made specifically for the purpose.

- H. Conduits shall be sized as indicated on the drawings and as required to accommodate the wires to be pulled into the conduit. Conduit shall not be less than three-quarters inch (3/4") in size except EMT for branch circuit runs may be one-half inch (1/2") and three-eighths inch (3/8") flexible metallic conduit may be used for individual connections to recessed lighting fixtures.

3.2 CONDUIT:

- A. Run conduits concealed from view in all areas except in electrical and mechanical equipment rooms. Run at levels and locations to avoid interference with the structure, finished ceilings, walls and all lines of other trades requiring grading of runs. Coordinate with other trades to allow available spaces to be used in the most efficient and workman like manner. In general, space and routing requirements of all other trades shall take precedence over the conduit installation.
- B. Route exposed conduits parallel with or at right angles to building walls and neatly rack. Carefully lay out conduit proposed to be run within the structure such as floors, beams, roof, or walls to avoid building up the density of conduits too excessive for the construction. Relocate conduits when excessive build-up occurs.
- C. Install conduits out of close proximity to any potentially hot device, any steam pipe, hot water pipe or other heating duct or appliance. Conduit shall not be run within three inches (3") of the exterior insulation of such device, pipe or duct, except in crossing, and such crossing shall be at least one inch (1") from the cover of the device, pipe or duct crossed.
- D. Place conduits through the roof or exterior walls in time to allow the trade to seal around the raceways as work is installed. Conduits through roof shall run through galvanized pitch pans.
- E. Cover each end of each conduit with an approved capped bushing as soon as the conduit is installed to prevent entry of foreign material. Conduits shall be dry and clean before wires are pulled.
- F. Locate junction boxes and raceways above accessible ceilings such as lay-in ceiling to provide adequate space for recessed fluorescent fixtures of the type specified elsewhere to be installed, in any place in the ceiling without relocating the installed raceways, boxes or supports now or in the future.
- G. Arrange conduit runs within building interiors to be no longer than 80 feet between pull or junction boxes, cabinets, or circuit interrupting device enclosures unless there is no direction change and only a straight-in-line pull of wire is involved. In such straight-in-line runs between boxes, cabinets or devices, runs not exceeding 100 feet in length may be made.
- H. Non-Metallic conduit installed outdoors under concrete slabs or walkways shall have 24 inches cover and may be in contact with the earth. Conduit service laterals installed under driveways, or roadways shall be encased in reinforced concrete. Support runs on PVC spacers 5'- 0" center-to-center and encase in reinforced concrete duct banks. Reinforcing shall be #4 deformed longitudinal bars, one each corner, with #3 stirrups tied at 1'- 0" reinforcing concrete shall cover bar minimum 2 inches around each corner face. Non-metallic conduit installed indoors under slabs shall have 12 inches cover. Non-Metallic conduit installed in crawl spaces shall be supported by approved hangers.

3.3 FITTINGS:

- A. Install double locknuts and a bushing at each rigid conduit termination except for terminations into threaded hubs.
- B. Wherever standard threaded couplings cannot be used, split couplings may be used.
- C. Provide expansion joints in conduits at all building expansion joints and wherever else the length of run requires.
- D. Provide expansion joints on all underground conduit where it rises above grade. Expansion joint shall be same material as underground conduit.

- E. Coat all threaded connections subject to moisture or under ground with cold galvanizing before making connection up.

3.4 PULL ROPE:

- A. Install a pull rope with each end properly marked for use and termination of the other end in each conduit installed and in which no conductors are installed under this Division of Work.

END OF SECTION

SECTION 26 01 20

WIRE AND CABLE - 600 VOLTS AND UNDER

PART 1 GENERAL

1.1 WORK INCLUDED:

- A. Furnish and install electrical wires and cables for the distribution of electric power, controls, grounding and signals for the electrical systems.

1.2 REFERENCE DOCUMENTS:

- A. The Special Provisions for Electrical Work are hereby made a part of this section of the work. Refer to Section 26 00 10.

1.3 SUBMITTALS:

- A. Submit complete manufacturers' specification data on each type of conductor to be supplied to the job.
- B. Include proposed colors, color markings and other identification as a part of the submittal.

1.4 QUALITY ASSURANCE:

- A. Electrical conductors shall be UL listed and bear the UL label.

PART 2 PRODUCTS

2.1 CONDUCTORS:

- A. Wires and cables shall have conductors of soft-drawn annealed copper having a conductivity of not less than 98% of that of pure copper.
- B. Where not specifically indicated otherwise, wire and cable insulation type shall be as follows:
 - 1. For general use - Type THHN or THWN, 600 volt.
 - 2. For branch circuits of No. 12 and No. 10 AWG - Type THHN, 600 volt.
 - 3. For control wiring - Type THHN 600 volts, No. 14 AWG minimum size.
 - 4. Wiring run underground - Type THHN/THWN, or XHHW 600 Volt.
 - 5. For fixture wiring - Type AF, 300 volts, No. 14 AWG minimum size.
 - 6. For branch circuit wiring run in fluorescent fixture channels - Type THHN, 600 volts, No. 12 AWG minimum size.
 - 7. See other sections of work for alarm communications and other low-energy systems wiring.
 - 8. All communication, and low voltage control wire run in plenum above ceilings and not protected by conduit shall be teflon coated plenum cable as required by code.
 - 9. Service and/or feeder wiring to panelboards may be XHHW at the Contractors option.
- C. Wire shall be solid for No. 10 and smaller and stranded for No. 8 AWG and larger unless indicated otherwise on the drawings.
- D. All wire and cable shall be factory-color coded. Colors for each phase and neutral shall be used consistently throughout each system. The following color codes shall be used and maintained throughout the system:

120/208V, 277/480V, OR 120/240V SYSTEMS

Phase A	Black	Orange
Phase B	Red	Brown
Phase C	Blue	Purple
Neutral	White	Gray
Ground	Green	Green
Isolated Ground	Green w/ Tracer	Green with Tracer
Switch Legs	Yellow	

On wires No. 6 and larger and where factory color is not available, wires and cables shall be color-coded by a one inch (1") wide band of colored Scotch tape on ends of each conductor, or by coating a 3" band at the end of the cable and in each pull box with brilliant waterproof lacquer.

2.2 TERMINATIONS, SPLICES AND TAPS:

- A. Cable terminations, splices and taps for copper conductors shall be:
 - 1. For Terminations - O. Z. Manufacturing Company or equal, Type XLH.
 - 2. Splices and Taps - O. Z. Manufacturing Company or equal, clamp-type solderless connectors except splices and taps for No. 8 AWG and smaller conductors may be Scotchlock Spring Connectors, Buchanan "B" cap, Ideal Wing Nuts or T & B "Piggy" connectors.

2.3 SUPPORTS:

- A. Supports for wiring in cabinets, panels, pull boxes, wireway and junction boxes shall be cable clamps and cable ties.
- B. Supports in vertical feeders shall be two-piece conduit type.

PART 3 EXECUTION

3.1 CONDUCTOR SELECTION:

- A. The minimum size of wire shall be No. 12 AWG except as noted otherwise on the Drawings or specified herein. All branch circuit home runs over 100 feet from panel, measured along the length of the raceway, shall be wired with No. 10 AWG minimum.
- B. The Drawings and Schedules generally indicate the number of wires in a conduit. Provide the proper number of wires in each conduit to complete the entire electrical system.

3.2 INSTALLATION:

- A. Route each conductor through an approved Electrical Raceway. Pull conductors into conduit only after all conduits and outlet boxes are permanently in place. Pull wires or strings shall be inserted only after the raceway installation is complete.
- B. Run feeders and mains continuously without splice from line to load terminals and identify phases in each pull box and in the gutters of each switchboard and panelboard in which they connect. Splices in feeders may be made only where designated on the Drawings or where specific prior approval is given.
- C. Neatly train, control and circuit wiring in cabinets, panels, pull boxes, wireways, and junction boxes and tie with T & B Ty-Rap nylon cable ties. Clamp or fasten control or circuit cabling in cabinets or other equipment with non-metallic nylon T & T Ty-Rap cable clamps and mounting brackets.

- D. Install cable supports per N.E.C. in all vertical feeders and in boxes provided for the feeders where not terminated in electrical panels or equipment within code distances. Supports shall be of the two-piece conduit type, which clamp each individual conductor firmly and tightens due to weight of cable.

3.3 TERMINATIONS, SPLICES AND TAPS:

- A. Connections of conductors to terminals shall be made by pressure connections. Solder joints will be permitted only for low voltage controls. Joints and splices shall be made with clamp type solderless connectors and insulated with rubber and friction tape or Scotch No. 33 plastic tape. Spring connectors may be used for splicing No. 8 AWG or smaller conductors.

3.4 SUPPORTS:

- A. Install supports to hold conductors in place in each panelboard, cabinet, pull box, junction box and wire-way.
- B. Install cable supports in vertical runs of conductors in cabinets and pull boxes.

END OF SECTION

SECTION 26 01 31

JUNCTION AND PULL BOXES

PART 1 GENERAL

1.1 WORK INCLUDED:

- A. Furnish and install junction and pull boxes where indicated or where necessary for installation of the wiring systems.
- B. Secure prior approval of the Architects for locations of all boxes not specifically located on the drawings.

1.2 REFERENCE DOCUMENTS:

- A. The Special Provisions for Electrical Work are hereby made a part of this Section of the Work. Refer to Section 26 00 10.
- B. See Section 26 01 90 for Supporting Devices.
- C. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- D. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.3 SUBMITTALS:

- A. Shop Drawings shall be submitted on each specifically fabricated junction or pull box. Section 01 30 00 - Submittal Procedures: Submittal procedures.

PART 2 PRODUCTS

2.1 MATERIALS:

- A. Junction and pull boxes shall be flush or surface type as indicated on the drawings or as required to fit into the building construction. Junction and pull boxes shall have screw covers. Small junction boxes, 100 cubic inches and smaller, for control or branch circuit wiring, shall be as specified for outlet boxes and with blank covers.
- B. Junction and pull boxes installed in walls and ceiling spaces shall be code-gauge galvanized steel with galvanized steel covers.
- C. Junction and pull boxes installed in floors shall be galvanized malleable cast iron with gasketed covers.
- D. Junction and pull boxes installed outdoors shall be weatherproof with watertight gasketed covers fastened with corrosion resistant screws.
- E. Except as otherwise indicated, boxes shall be not less than code requirements.

PART 3 EXECUTION

3.1 INSTALLATION:

- A. Install junction and pull boxes in a neat workmanlike manner and support in accord with the provisions set forth elsewhere for panelboards and for hangers and supports.
- B. Arrange for raceways to enter boxes only in places specifically planned for raceways in the sizing and construction of the cabinets.
- C. Provide auxiliary conductor supports in large boxes per N.E.C. 370-18 where conductors must be supported.

3.2 LABELING:

- A. Conductors passing through the boxes shall be marked as to phase.

END OF SECTION

**SECTION 26 06 12
EMERGENCY POWER SYSTEM
(NATURAL GAS)**

PART 1 GENERAL

1.1 DESCRIPTION:

- A. Description of System: Provide essential power system including generator controls, transfer switch, and associated equipment. Provide a fully complete, compliant to applicable code, turn-key in nature, and ready for use by the end user.

1.2 QUALITY ASSURANCE:

- A. Reference Standards:
 - 1. Underwriters Laboratories, Inc. (UL) applicable standards
 - 2. National Electrical Manufacturers Association (NEMA) applicable standards
 - 3. National Electrical Code (NEC) 1981 applicable articles
 - 4. Other state and local codes applicable provisions

1.3 SUBMITTALS:

- A. Samples: Provide samples upon written request.
- B. Shop Drawings: Layouts giving dimensions, weights, locations, elevations, conduit and wiring provisions, power and control wiring diagrams.
- C. Product Data: Sizes, types, materials and finishes, air data, fuel consumption data, engineering design tolerances and criteria, performance data at 1/4, 1/2 and full loading; storage and handling instructions, and installation directions.
- D. Test Reports: Copies of tests results at factory and of tests results for compliance to referenced standards.
- E. Certificates:
 - 1. UL labels affixed to materials
 - 2. Evidence of compliance to reference standards
- F. Operation and Maintenance Data: Manufacturers brochures and parts lists.
- G. Maintenance Materials:
 - 1. Listing of local stocks of applicable spare parts
 - 2. Listing of non-local stocks of applicable spare parts
 - 3. Listing of non-stocked replacement parts
- H. See Section 01 30 00 – Submittal Procedures

1.4 PRODUCT STORAGE AND HANDLING:

- A. Storage: Store at locations where not subject to damage from personnel, equipment and the elements.
- B. Handling: Handle to avoid damage to materials and surrounding surfaces and finishes before and during installation.

1.5 JOB CONDITIONS:

**SECTION 26 06 12
EMERGENCY POWER SYSTEM
(NATURAL GAS)**

- A. Protection: Protect materials and surrounding surfaces and finishes against damages from personnel, equipment and the elements before, during and after installation.
- B. Sequencing: Install materials at times required to prevent unnecessary delays in the work.

1.6 WARRANTY:

- A. Warranty: Warranty system against defects for five (5) years from and after date of acceptance. Repair defects promptly during warranty period.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Basis of Design: Kohler
- B. Cummins, Catapiller, Kohler, or Onan.
- C. Russelectric, Asco, or Onan ATS.
- D. Approved equal

2.2 MATERIALS:

- A. Generator/Engine Set: Capacity and voltage as shown on drawings. Prime mode operation at 100 degrees ambient temperature.
- B. Engine:
 - 1. Water Cooled
 - 2. Compression Ignition for natural gas
 - 3. 1800 RPM at normal full load
 - 4. Isochronous Electronic governor
 - 5. Replaceable element fuel filter
 - 6. Lubrication:
 - a. gear-type oil pump for pressure lubrication
 - b. spin-on type filters with spring loaded bypass valve
 - 7. Cylinder liners:
 - a. removable
 - b. wet-type
 - c. close-grained alloy iron
 - 8. Heavy-duty dry type air cleaners
 - 9. Starting:
 - a. lead acid batteries
 - b. 40 second cranking
 - c. necessary rack and cables
 - d. alternator and dual rate trickle charger
 - 10. Engine block heater to maintain 120 degree to 140 degree F with lube oil pressure switch for auto cutout.
 - 11. Instruments:
 - a. water temp.
 - b. oil pressure
 - c. oil temp.
 - d. elapsed time meter

**SECTION 26 06 12
EMERGENCY POWER SYSTEM
(NATURAL GAS)**

- e. charging indicator
 - f. oil pressure, water temp.
 - g. overspeed indicators
 - 12. Cooling:
 - a. engine-driven centrifugal water pump and thermostatic valve
 - b. spin-on type water filters
 - c. 33% ethylene glycol antifreeze
 - d. guarded, engine-mounted radiator, blower fan, and venturi shroud
 - 13. Exhaust system:
 - a. critical silencing muffler with rain cap, mounted above enclosure
 - 14. Safety controls for auto shut-down
 - a. low oil pressure
 - b. high oil pressure
 - c. overspeed
 - d. overcrank
 - e. low water level
 - f. alarm lights for a through e and auxiliary contacts
 - g. pre-alarm signals
 - (1) high water temp.
 - (2) overspeed
 - 15. Mounting:
 - a. full-length steel channel sub-base
 - b. spring-type vibration isolators
 - c. weatherproof housing
 - d. base mounted day tank with fuel gauge
- C. Generators:
- 1. Brushless, revolving field type
 - 2. Flexible driving disc directly coupled to engine flywheel
 - 3. Dynamically balanced rotor to 25% overspeed
 - 4. Exciter
 - a. rotating field, brushless
 - b. full wave three-phase rectifier with surge protection
 - 5. Rotor:
 - a. layer wound with thermo-setting epoxy between layers and for final coat
 - b. bearing:
 - (1) shielded type
 - (2) grease pipes to exterior of frame.
 - (3) 40,000 hour life
 - 6. Stator:
 - a. 2/3 pitch design
 - b. dip in varnish and bake five times
 - c. overall epoxy coating
 - d. harmonic distortion less than 5% total RMS line to line at full load
 - 7. Connection box:
 - a. side mounted
 - b. ventilated
 - c. bottom entry
 - 8. Voltage regulator:
 - a. solid state with SCR control
 - b. Rheostat for 10% voltage adjustment
 - 9. Main circuit breaker set for 150% rated current
- D. Performance:
- 1. Voltage regulation no-load to full-load not to exceed $\pm 1\%$.

**SECTION 26 06 12
EMERGENCY POWER SYSTEM
(NATURAL GAS)**

2. Steady state voltage within 0.5% of rated.
 3. Modulation at steady state not to exceed one cycle per second.
 4. For addition of 90% load at 0.8 PF, voltage dip not to exceed 20%; full recovery within 4.5 seconds.
 5. For addition of 9-% load at 0.8 PF, frequency change not to exceed one cycle per second; full recovery within 7.0 seconds.
 6. Balanced TIF not to exceed 50%.
 7. If a short circuit occurs, capable of supporting 300% rated current for 10 seconds.
- E. Control Panel:
1. Mounted on generator.
 2. Instruments
 - a. voltmeter
 - b. ammeter
 - c. frequency meter
 - d. combination ammeter-voltmeter phase selector switch
 - e. instruments required in 2.02, B, 15, above
 - f. auto-start control
 - g. wattmeter
 - h. pre-alarm lights
 - i. horn
 - j. signal silence switch
 - k. contacts for remote on-off-trouble wiring
- F. Automatic Transfer Switch (ATS):
1. Manufacturer, Capacity and voltage as shown on drawings.
 2. NEMA 3R enclosed, front access only
 3. Longtime withstand short circuit rating of 200 KAIC symmetrical with Bussman KRP-C, 1800 amp fuses
 4. Conforming to U.L. 1008
 5. Dual motor operator with minimum 400 msec transfer time
 6. Manual operator with same transfer time
 7. Engine starting contacts with time delay set at 3 seconds
 8. Transfer when genset reaches 90% rated voltage
 9. 0 - 30 minute adjustable time delay for retransfer to normal set at 15 minutes, with genset failure override
 10. 0 - 5 minutes adjustable time delay for engine cooldown set at 5 minutes
 11. Integral test switch
 12. Switch position indicating lights
 13. Russelectric RMTD.
- H. Remote alarm annunciator panel:
- High Battery Voltage
Low Battery Voltage
Normal Battery Voltage
Gen Running
EPS Supply Load
Pre-low OK Press.
Low or Press.
Pre-high Coolant Temp.
High Coolant Temp.
Low Engine Temp.
Overspeed
Overcrank

**SECTION 26 06 12
EMERGENCY POWER SYSTEM
(NATURAL GAS)**

Not-in-Auto
Battery Chg Malfunction
Low Fuel
Fault Lamp Test Button
Normal Util. Power

Provide options as requested by owner prior to purchase. Allow owner to select final options.

PART 3 EXECUTION

3.1 INSPECTION:

- A. Examine materials upon receipt for damages.
- B. Examine completed installation for proper adjustments and performance.

3.2 PREPARATION:

- A. Carefully layout exact locations of materials in conference with the Owner's representative.
- B. Provide foundation per structural drawings.

3.3 INSTALLATION:

- A. Install materials at indicated locations and as required by authorities having jurisdiction and the manufacturers.
- B. Provide remote monitoring annunciator panel.

3.4 FIELD QUALITY CONTROL:

- A. Test: Prior to acceptance of the installation, the equipment shall be subjected to an on site test at full load with resistive load banks for a minimum of 4 hours. All consumables necessary for this test operation shall be furnished by the contractor. Any defects which become evident during this test shall be corrected by the contractor at his own expense. Tests shall be conducted in presence of Owner's representative.

3.5 ADJUSTMENTS AND CLEANING:

- A. Adjustments: Perform necessary work required to provide proper systems performance.
- B. Cleaning:
 - 1. Remove foreign material from materials.
 - 2. Clean surfaced to be painted.
 - 3. Touch up damaged finishes.
- C. Training:
 - 1. Provide 8 hours training for Owner's personnel covering features, operation

**SECTION 26 06 12
EMERGENCY POWER SYSTEM
(NATURAL GAS)**

- and maintenance of system.
2. Coordinate training two weeks prior to testing to occur one day prior to testing at site.

END OF SECTION